PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. V. 1865–66. No. 70.

Monday, 5*th February* 1866.

SIR DAVID BREWSTER, President, in the Chair.

The following Communications were read:—

1. On the Laws of the Fertility of Women. By J. Matthews Duncan, M.D.

This paper was a sequel of a paper read to the Royal Society, and published in the 23d volume of the "Transactions." That paper was entitled, "On the Variations of the Fertility and Fecundity of Women, according to age;" and among other conclusions therein announced, was one to the effect that fecundity, or likelihood of child-bearing after marriage, increased from the earliest child-bearing age till about twenty-five, and thereafter gradually decreased. In the present paper, the laws regulating such fertility after marriage are demonstrated. The chief data on which the arguments for these laws are based are derived from an analysis of 16,301 families, in connection with which entries were made in 1855 in the public registers for Edinburgh and Glasgow.

The fertility of marriages in Scotland is shown by the reports to the Registrar-General to be about 4·64 children to a marriage. But this statement is of no physiological value, since all marriages are included in it, comprising those at all ages and of all durations, &c. A statement of the fertility of Scottish wives, a little more

exact, is got by dividing the number of married women of child-bearing age by the number of legitimate children born, all in the same year. It is thus found that every 3·55 wives, aged from fifteen to forty-five, add one to the population annually.

The fertility of all marriages in Edinburgh and Glasgow that were fertile in 1855 is found to be 3·7 children to a marriage. The fertility of fertile marriages enduring for the whole child-bearing period of life is shown to be on an average ten children to a marriage; and as the average interval between successive births is about twenty months, fertile women, living in wedlock, from fifteen to forty-five, are fecund for about seventeen years.

The fertility of persistently fertile marriages, lasting during the whole child-bearing period of life, is shown to be at least fifteen children to a marriage. Persistently fertile wives, taken at any duration of marriage, are found to have born at the rate of a child very nearly every two years.

It is shown that, at any epoch in married life, the average number of a fertile woman's family is one-third of the number of years elapsed since her marriage, and that the number of a persistently fertile woman's family is one-half of the number of years elapsed since her marriage. These numbers vary according to the age of the wives at marriage — a circumstance which is subsequently explained.

The average interval between marriage and the birth of a first child is shown to be seventeen months. Inclusive of this period, the interval between the births of successive children is twenty months. In average families, the first four children succeed one another more rapidly than the next six—that is, on to the tenth. But in large families, or those above ten, the children, from the first, do comparatively hurry after one another with brief intervals.

Fertile women, married at different ages, have an amount of fertility which decreases as the age at marriage increases; and this greater total fertility arises from the greater continuance or persistence in fertility of the younger married. Women married at higher and higher ages have a shorter career of fertility. This perseverance in fertility explains why the women married from fifteen to twenty years of age have a greater fertility than those married from twenty to twenty-five, who have the highest fecundity or like-

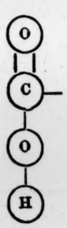
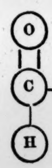
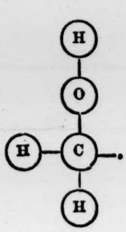
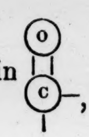
lihood to have children, and specially a greater probability of being fertile than those married from fifteen to twenty.

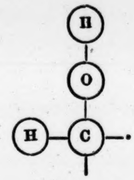
Wives who are persistently fertile are more fertile the older they were at the time of marriage. In other words, the older a woman, destined to be fertile, is at the time of marriage, the greater will be her fertility so long as it lasts. The fertility of a woman old at marriage is greater than that of a woman young at marriage; yet the total fertility of women married young far exceeds that of women married when elderly, reckoning for both sets equal durations of marriage, and all within the child-bearing period; because of the younger a far larger proportion are fecund, and because the younger have a far longer continuance of fertility.

The increasing frequency of twin-births as age advances is explained by this law of increasing intensity of fertility as age advances.

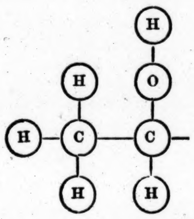
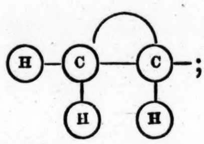
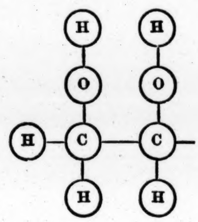
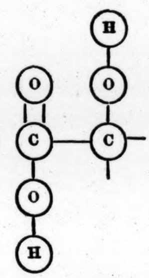
Women married when elderly have been supposed by some authors to have a special postponement of the generative orgasm, to enable them to bear children beyond ordinary periods. But this is shown not to be the case, by the circumstance that most women child-bearing at very high ages are already mothers of considerable families.

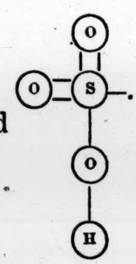
2. On the Classification of Chemical Substances by Means of Generic Radicals. By Dr Alexander Crum Brown.

In this paper the author proposes to use for purposes of classification those radicals or parts of molecules which are common to *genera* of substances, and within which the changes characteristic of these genera take place. Thus the carbon acids contain the group or radical ; the aldehydes , and the "true" alcohols . In the same way, as the acetones contain ,

the pseudo-alcohols derived from them must contain 

By a comparison of various reactions it is shown that the group characteristic of the olefine-hydrates is probably

 ; that of the olefines,  ; that of the glycols  ; that of the lactic acid class 

and that of the organic acids derived from sulphuric acid 

Such groups of atoms may be called generic radicals, as the distinguishing characters of a genus depend on the presence of one of them, and the individual substances may be classified as compounds of these radicals. In conclusion, some substances are mentioned which consist entirely of such radicals, as glycol $(CH_2HO)_2$, glyoxal $(COH)_2$, oxalic acid $(CO\,HO)_2$, hypo-sulphuric acid $(SO_2HO)_2$, glycolic acid $(CH_2HO)\,(CO\,HO)$, glyoxylic acid $(COH)\,(CO\,HO)$, glycerine $(CH\,HO)''\,(CH_2HO)_2$, tartronic acid $(CH\,HO)''\,(CO\,HO)_2$, glyceric acid $(CH\,HO)''\,(CH_2HO)\,(CO\,HO)$, mesoxalic acid $(CO)''\,(CO\,HO)_2$.

3. Note on the Compression of Air in an Air-bubble under Water. By Professor TAIT.

In an air-bubble of moderate dimensions the pressure is very little greater than that of the atmosphere; but, as the difference of pressures within and without a bubble is proportional to its curvature, it appeared to me possible that the so-called solution of air in water might be due in some degree to the extreme compression of the air when divided into small bubbles invisible perhaps even under the microscope.

For a rough attempt at a solution, let us assume air to follow Boyle's law for all pressures, and suppose the common formula

$$p - p_0 = \frac{2T}{r}$$

to hold for the smallest bubble.

Both of these assumptions are probably far from correct—the first, when the condensation of the air is great; and the second, when the dimensions of the bubble are so small as to be comparable with the greatest distance at which molecular forces are sensible.

If R be the radius of the sphere which the contained air would occupy at the pressure of the atmosphere p_0; r the radius of the bubble, and p the pressure inside,

$$p = \frac{R^3}{r^3} p_0.$$

Eliminating p by the help of the first equation,

$$\left(\frac{r}{R}\right)^3 + \frac{2T}{Rp_0}\left(\frac{r}{R}\right)^2 - 1 = 0.$$

Now, by experiments on the rise of water in capillary tubes, it is found that the value of $\frac{2T}{p_0}$ is, roughly, ·0001 inch, if T be the tension per linear inch, p_0 the pressure per square inch. From the smallness of this quantity it appears that unless R be very small, the second term of the above cubic is of little consequence, and therefore the dimensions of the bubble are little altered.

But if R be very small the second term is of more importance than the first. The following are rough approximations only:—

R in.	$\frac{r}{R}$	$\frac{p}{p_0}$
0·0001	·75	2·3
0·00001	·3	35
0·000001	·1	1000
0·0000001	·03	33,000.

An air-bubble whose radius is ·00001 inch, which is about the smallest that can be observed by means of a good microscope, contains air compressed to 11 atmospheres only.

When the bubble is detached from the fluid each of its surfaces contributes its share to the excess of internal, over external pressure. (W. Thomson, *Proc. R. S.* 1858.) In this case the equation above becomes

$$\left(\frac{r}{R}\right)^3 + \frac{4T}{Rp_0}\left(\frac{r}{R}\right)^2 - 1 = 0,$$

at least until r becomes so small that the thickness of the film must be taken into account. The following numbers, therefore, refer to the case of vesicular vapour which is supposed by Clausius and others to account for the blue of the sky and the morning and evening red. As I have considered it unnecessary to allow for the thickness of the film, the later results are too large:—

R. in.	$\frac{r}{R}$	$\frac{p}{p_0}$
0·0001	·62	4·3
0·00001	·22	94
0·000001	·07	2740
0·0000001	·022	98,000.

Little is gained towards a closer approximation by applying analysis such as that of Laplace or Gauss to this question. If we express by $\phi(r)$ the law of molecular action as depending on the distance, we know merely that ϕ is insensible for sensible values of r. The complete solution of the problem can, no doubt, be given by a direct application of Laplace's process. Thus, if we write

$$\psi(r)=\int rdr\int\phi(r)dr,$$

the attraction of a uniform spherical shell, of radius a, on an

external unit of matter placed at a distance r from its centre is represented by

$$2\pi\rho a da \frac{d}{dr}\left\{\frac{\psi(r+a)-\psi(r-a)}{r}\right\}.$$

Integrating between the limits 0 and a $(a<r)$ for a, we have the attraction of a uniform sphere on an external point. Forming the equation of fluid equilibrium on the supposition that such a spherical portion ceases to exert molecular force, we find the expression for the pressure in the fluid at a distance r from the centre of the bubble. This contains the following new functions

$$\omega(r)=\int rdr\int rdr\int\phi(r)dr,$$

and

$$\chi(r)=\int dr\int rdr\int\phi(r)dr,$$

but, from the manner in which they appear in the final expression, it is impossible to determine the relative importance of the terms containing them.

We see, however, that the terms in ω, which are multiplied by the curvature, become somewhat less as the radius of the bubble diminishes—so that the calculated pressures given above are possibly too large.

4. On some Geometrical Constructions connected with the Elliptic Motion of Unresisted Projectiles. By Professor Tait.

In "Tait and Steele's Dynamics of a Particle," chap. iv., a number of geometrical constructions are given, some possibly for the first time, connected with the motion of projectiles in parabolic paths in vacuo. I have recently been led to remark that most of these propositions still hold when we substitute, for the uniform action of gravity in parallel lines, the action of gravity supposed to be directed to the earth's centre, and to vary inversely as the square of the distance from that point. My excuse for bringing so simple a matter before the Society is, that the propositions are in themselves curious and elegant, and that I am not aware of their having been before mentioned. A very few examples will suffice to indicate the change of form required by the more general assumed conditions. The following may be taken for this purpose :—

1. The locus of the second foci of the paths of all projectiles leaving a given point, with a given velocity, in a vertical plane, is a circle.

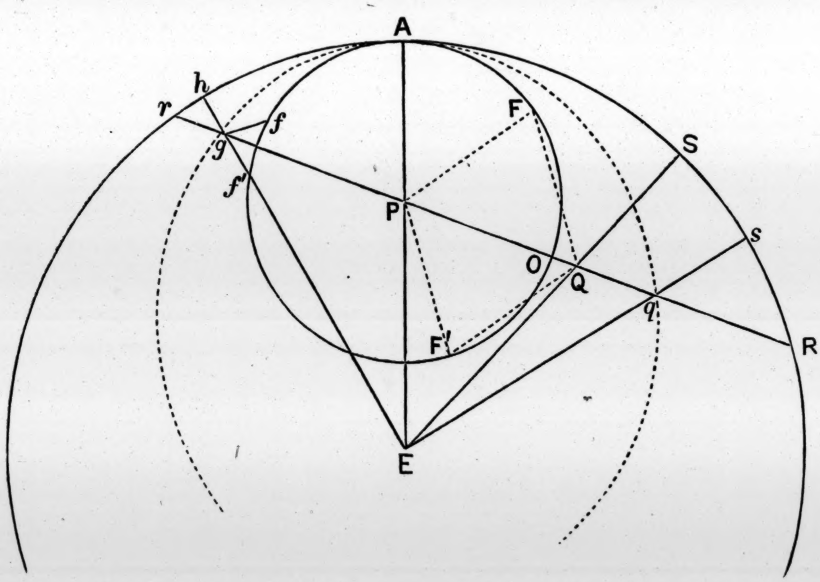
2. The direction of projection for the greatest range on a given line, passing through the point of projection, bisects the angle between the vertical and the line.

3. Any other point on the line which can be reached at all, can be reached by *two* different paths, and the directions of projection for these are equally inclined to the direction which gives the maximum range.

4. If a projectile meet the line at right angles, the point which it strikes is the vertex of the other path by which it may be reached.

5. The envelop of all possible paths in a vertical plane is an ellipse, one of whose foci is the centre of the earth, and the other the point of projection. (In the simpler case this is a parabola.)

The proofs of these propositions are extremely simple. Thus, let E be the earth's centre, P the point of projection, A the point



which the projectile would reach if fired vertically upwards. With centre E, and radius EA, describe a circle in the common plane of projection. This corresponds to the common directrix of the parabolic paths in the ordinary theory. If F be the second focus of

any path, we must have EP + PF constant, because the axis major depends on the *velocity*, not the *direction*, of projection. Hence (1) the locus of F is the circle AFO. Again, since, if F be the focus of the path which meets PR in Q, we must have FQ = QS; it is obvious that the greatest range Pq is to be found by the condition Oq = qs. O is therefore the second focus of this trajectory, and therefore (2) the direction of projection for the greatest range on PR bisects the angle APR. If QF = QF′ = QS, F and F′ are the second foci of the two paths by which Q may be reached; and, as $\angle$ FPO = $\angle$ F′PO – we see the truth of (3). If Q be a point reached by the projectile when moving in a direction perpendicular to PR – we must evidently have PQF′ = $\angle$ PQF = $\angle$ SQR = $\angle$ EQP; *i.e.*, EQ passes through F′. This case is represented on the other side of the diagram—where $f'g = gh = fg$. The ellipse whose second focus is f evidently meet Pr at right angles: and that whose second focus is f' has (4) its vertex at g. The locus of q is evidently the envelop of all the trajectories. Now

$$Pq = PO + Oq = PA + Oq,$$
$$Eq = Es - sq = EA - Oq.$$

Hence

$$Pq + Eq = PA + AE,$$

or (5) the envelop is an ellipse, whose foci are E and P, and which passes through A.

5. On the Fairy Stones found in the Elwand Water near Melrose. By Sir David Brewster, K.H., F.R.S.

On the banks of the Elwand Water, which runs into the Tweed, about two miles above Melrose, there is a picturesque glen called the Fairy Dean, which has become a favourite place of resort, from its association with the incidents in "The Monastery" by Sir Walter Scott. It has acquired an interest of a different kind from certain mineral concretions which have received the name of *Fairy Stones*, from their being found in that part of the rivulet which runs through the Fairy Dean.

When the Waverley Novels were not acknowledged by their author, facts or incidents to which they referred, were always wel-

come subjects of conversation at Abbotsford; and on one occasion when I happened to mention that singular stones were found in the Fairy Dean, Sir Walter Scott expressed a desire to see them, and to know how they were formed. I accordingly sent some young persons to search for them in the bed of the rivulet, and I was fortunate in thus obtaining several specimens of great variety, and singular shape, and showing, very clearly, the manner in which they were formed.

It did not then occur to me that a description of these stones would excite any other than a local interest; but, some years ago, when in company with our distinguished countryman Mr Robert Brown, the *Botanicorum facile Princeps* of Humboldt, he asked me to accompany him to his museum, to see some remarkable mineral productions which had been sent to him, and which he had not seen before. These minerals were exactly the same as the Fairy Stones from Roxburghshire, but none of them were so remarkable, either in their shape or their mode of formation, as those which I now present to the Society.

The Fairy Stones are generally of a grey colour, like common freestone, but some of them are coated to the thickness of about the seventieth of an inch, with a black substance, so soft as to produce a black streak upon paper like a crayon.

These stones are generally formed of concentric layers more or less regular round a single centre, as in figs. 1 and 2, some of them

Fig. 1.

Fig. 2.

having the form of a lens, ocasionally so deep, as to be almost a sphere. In many specimens the concentric layers are formed round two centres, as in fig. 3; in some round three centres, and in others round many centres, as in figs. 4 and 5.

In a few specimens, when the concentric rings round two centres

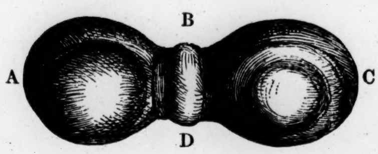


Fig. 3.

Fig. 4.

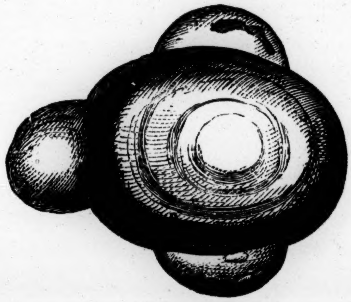


Fig. 5.

have come into contact, as in fig. 3, the rings take the shape ABCD like the Lemniscates in biaxal crystals.

Fig. 6.

In one remarkable specimen, shown in fig. 6, the different portions are disposed with such extraordinary symmetry as to give it the appearance of a fossil.

It is obvious, from the inspection of the specimens on the table, that the Fairy Stones are formed by the dropping of water containing the matter of which they are composed. This is clearly shown in two of the specimens on the table, where the fluid matter has been deposited upon fragments of whinstone, though in one of these specimens (fig. 7) the deposits at AA are so deeply imbedded as to have the appearance of contemporaneous formations.

When the stones have a symmetrical structure on the under as well as on the upper side (as in fig. 8), it is difficult to understand

Fig. 7.

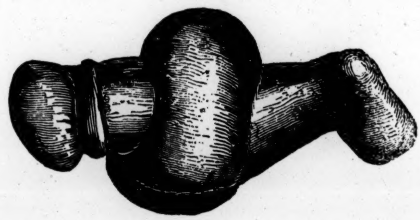


Fig. 8.

the mode of their formation, unless we suppose that the deposit has been made upon a soft stratum of clay or sand, or any other material with which the deposited matter will not combine, and from which it may be easily separated.

This difficulty is increased when the specimen has the form of a ring, as in fig. 9.

Fig. 9.

According to a rough analysis, which Dr Dalzell has been so good as to make for me; the specific gravity of the Fairy Stones is 2·65, and their odour, when breathed upon, argillaceous. They

effervesce with mineral acids, and contain the following ingredients proportionally in the order in which they are written :—*Alumina*, *Silica*, *Lime*, *Magnesia*, *Oxide of Iron*, and a trace of *Manganese.*

The black coating on many of these stones, which is too minute for analysis, and which may be easily removed, is very remarkable. If it is not carbonaceous it must be an aluminous deposit, when the particles of the aluminous solution have become so small as to be unable to reflect light. This supposition will not appear unreasonable to those who have seen the surfaces of fracture of certain specimens of quartz, where the separated fibres are so minute as to be incapable of reflecting the lowest order of tints in Newton's scale. The specimen of quartz in which I observed this very remarkable phenomenon was, I believe, exhibited to the Society. Mr Haidinger afterwards found a less perfect specimen in which the surfaces of fracture were equally black.

The following Gentlemen were admitted Fellows of the Society :—

John M'Nair, Esq.
Professor Spence.
Thomas Nelson, Esq.

The following Donations to the Library were announced :—

Transactions of the Royal Scottish Society of Arts. Vol. VII. Part 1. 8vo.—*From the Society.*

Philosophical Transactions of the Royal Society of London. Vol. CLV. Part 2. London, 1865. 4to.—*From the Society.*

Proceedings of the Royal Society of London. Vol. XV. No. 80. 8vo.—*From the Society.*

List of the Royal Society of London, 30th Nov. 1865. 4to.—*From the Society.*

Sketch of the History of the High Constables of Edinburgh. By James Marwick, F.R.S.E, Edinburgh, 1865. 8vo.—*From Charles Lawson, Esq.*

Journal of the Royal Horticultural Society of London. New Series. Vol. I. Part 1. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society of London. Vol. V. No. 9. 8vo.—*From the Society.*

Transactions of the Historic Society of Lancashire and Cheshire. New Series. Vol. IV. Session 1863-64. Liverpool, 1864. 8vo.—*From the Society.*

Journal of the Asiatic Society of Bengal, 1865. Part 1. No. 3. Part 2. No. 3. Calcutta, 1865.—*From the Society.*

Journal of the Chemical Society of London. No. XXXVI. 8vo. —*From the Society.*

The Canadian Journal of Industry, Science, and Art. No. 60. Toronto, 1865. 8vo.—*From the Editors.*

Die Fortschritte der Physik in Jahre, 1863. Dargestellt von der Physikalischen Gesellschaft zu Berlin XIX. Jahrgang Erste. Zweite Abtheilung. Berlin, 1865. 8vo.—*From the Society.*

Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1864. Nos. 1-10. Stockholm, 1865. 8vo.—*From the Academy.*

Kongl. Svenska Vetenskaps-Akademiens Handlingar. Bd. 5. Hft. 1. 1863. 4to.—*From the Academy.*

Meteorologiska Iakttagelser i Sverige Utgifna af Kongl. Svenska Vetenskaps-Akademien auställda ach bearbetade under Insende af Er. Edlund. Bd. 5. 1863. 4to.—*From the Academy.*

Bulletin de L'Academie Royale des Sciences, des Lettres, et des Beaux Arts, de Belgique. Tome 20, Nos. 11, 12. Tome 21, No. 1. Bruxelles. 8vo.—*From the Academy.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome VII. No 1. 8vo.—*From the Society.*

Bulletin de la Société Vaudoise des Sciences Naturelles. Tom. VIII., No. 53. Lausanne, 1865. 8vo.—*From the Society.*

Annales des Mines ou recueil de Mémoires sur L'exploitation des Mines. Tome VIII. 4e. Livraison, Paris, 1865. 4to.—*From the Ecole des Mines.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. Band XV. No. 3. Wien. 8vo.—*From the Society.*

Schriften der Universität zu Kiel aus dem Jahre, 1864. Band XI. Kiel, 1865. 4to.—*From the University.*

Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857-58-59 unter den Besehen des Commodore B. von Wullerstorf-Urbair Nautisch-Physicalischer Theil. II. Abtheil. Magnetische Beobachtungen. Wien, 1865. 4to.—*From the Austrian Navy Board.*

Monday, 19th February 1866.

Sir DAVID BREWSTER, President, in the Chair.

The following Communications were read :—

1. Report on the Hourly Observations made at Leith Fort in 1826 and 1827, by Direction of the Society. By Sir David Brewster, K.H , D.C.L., F.R.S., &c.

In 1823 the Royal Society established a register of hourly observations of the thermometer at Leith Fort. They were made by the non-commissioned officers of artillery, and were continued for four years, from 1824 to 1827 inclusive. A report on these observations for the years 1824 and 1825 was published in the tenth volume of the Society's Transactions; but from causes to which it is unnecessary to refer, the report on the observations of 1826 and 1827 were not then published.

The great interest which was attached to meteorological observations, but specially to those made every hour, has induced the author to publish the results which he has obtained from the original registers in the Library of the Society.

The agreement of these results, with those obtained from the observations in 1824 and 1825, is very remarkable.

2. On a New Property of the Retina. By Sir David Brewster, K.H., D.C.L., F.R.S., &c.

In a paper on hemiopsy,* the author had shown that the parts of the retina affected with this disease were susceptible of luminous impressions and insensible to visual ones, and that the light by which they were impressed was derived by irradiation from the adjacent parts of the retina. The parts of the retina affected with hemiopsy were, however, so small, so irregularly distributed, and the phenomenon of such short duration, that it was difficult to study it and deduce any satisfactory results.

From an accidental observation the author discovered that a

* Transactions, vol. xxiv. p. 15.

portion of the retina of his right eye, though the vision of the eye was perfect, was actually blind or insensible to visual impressions, while it was so sensible to luminous impressions, that no spot of the slightest darkness or shade was seen in the field of vision when directed to the sky or any extended white surface. When the image of a bright object, or of the setting sun, was received on this portion of the retina, which was about the twenty-eighth part of an inch in breadth, it was wholly invisible, and therefore the light with which it was impressed must have been derived by irradiation from the adjacent parts of the retina, or from those parts of it which underlie the insensible part. But for this property the patient would constantly see a black spot disfiguring the aspects of nature, and ever reminding him of his misfortune.

The author mentioned a temporary affection of the same eye, observed thirty years ago, on which two lines, radiating from the foramen centrale, were *absolutely black*.

3. On some Laws of the Sterility of Women. By J. Matthews Duncan, M.D.

In this paper absolute sterility is held to mean the condition of a woman who, under ordinary favourable circumstances for breeding, produces no living or dead child, nor any kind of abortion. Sterility is held to mean the condition of a woman who, under ordinary favourable circumstances for breeding, produces no living and viable child, or adds not one to the population. Relative sterility is held to mean the condition of a woman who, while she may or may not be absolutely sterile, while she may or may not be sterile, is, under ordinary favourable conditions for breeding, sterile in relation to the circumstance of time, or, in other words, in relation to her age and the duration of her married life.

The sterility of marriages in our population is estimated as 19 per cent.

The sterility of wives, married at ages from 15 to 44 inclusive, is shown to be 15 per cent, or about 1 in 6½.

The absolute sterility of wives may be held to approximate closely to the sterility of wives; for to the data used in calculating the sterility of wives there would only have to be added the wives

bearing dead children only, or abortions only, or both (and the number of these is probably inconsiderable), in order to get the absolute sterility of wives.

Sterility varies according to the age of the woman at marriage. About 7 per cent. of the women married from 15 to 19 years of age are sterile. Of those married from 20 to 24 years of age, almost none are sterile. After 24 years of age, sterility reappears and increases progressively with the age at marriage.

Expectation of sterility begins after three years' of marriage, for only 7 per cent. of fertile wives commence child-bearing after that period has elapsed.

The probability of a woman's being sterile is soonest decided at the ages at which the probability of fertility is greatest.

Relative sterility is sooner arrived at according as the age at marriage is greater. This is merely the converse of the law of continued fertility, that being greater according as the age at marriage is less.

Expectation of relative sterility commences after three years of cessation of fertility, and increases as more time elapses.

4. On certain Points in the Morphology of Cleft Palate. By John Smith, M.D., F.R.C.S.E. Communicated by William Turner, M.B.

In cases of cleft palate with alveolar fissure, the maxillary bones are, during infancy, not only ununited, but, in general, if not always, more widely separated from one another than in the natural condition. This has been frequently observed in such cases as come under the care of the surgeon, although little attention appears to have been bestowed upon the fact beyond its mere casual mention. Measurements, however, have been lately made by Dr Engel,* showing that the difference between certain fixed points—such as the two infra-orbital foramina, the nasal processes of the upper jaw, &c., is very well marked, when the distance is measured in a healthy new-born child, compared with one having a cleft palate.

* Prag. Vierteljahrschrift. 1864. P. 115.

In these cases, he describes the width of the nostril on the affected side as greater, the bridge of the nose less arched, and the distance between the two orbits increased. In all cases, the lower ends of the nasal bones project further forwards than in healthy new-born children. The nasal processes of the frontal bone in bilateral cleft palate are shown by him to be broader, the width between the tubera frontalia to be increased; and besides the two eyes being further removed from each other, the form and size of the orbits are altered; and both in bilateral and unilateral cases are seldom equal in size. The minute details of a case are also given by him where, associated with double cleft palate, there was a great addition both to the breadth and depth of the basis cranii in the ethmoid and orbital portions of the frontal region: a condition he considers to bear a "causal relation" to the occurrence of cleft palate.

The increased breadth of the anterior part of the head he considers as necessitating a greater distance between the superior maxillæ than can be filled up by the development of the intervening structures. And the cause, again, of this increased breadth of the head he believes due to various circumstances, such as congenital hernia cerebri, dropsy of the third ventricle, or anterior cornua of the lateral ventricles, or excessive development of the anterior cerebral lobes. Owing to such distension within the cranium of the embryo, he shows the parts on each side of the palatal fissure to be, in the young subject, not only deficient in the middle line, but further asunder than in the normal condition.

These circumstances become somewhat more interesting if we contrast them with what appears to occur in the adult. Here the transverse distance between the palatal sides of the upper right and left anterior bicuspids will, in an ordinarly well-formed jaw, be found to measure from one and an eighth to one and a quarter of an inch. The measurements afforded at the same spot, in sixteen adult cases of cleft palate, of which I have collected casts, are somewhat less than this; and in others, of which I have not preserved a record, the same peculiarity was observed. Among the cases noted, the measurements at the point already described, are as follows; the canines of the opposite sides—which, by the way, are always present in these cases—being in some, of course, much closer than the bicuspids.

In six cases where the intermaxillary bones seemed altogether absent—probably cases originally of double cleft—where these bones had been removed by the surgeon—or of others where they had never been developed—

1 case	measured	$\frac{3}{8}$ths of an inch.
1 „	„	$\frac{5}{8}$ths „
2 cases	„	$\frac{7}{8}$ths „
1 case	„	1 inch.
1 „	„	$1\frac{1}{8}$th of an inch.

giving an average measurement of between $\frac{6}{8}$ths and $\frac{7}{8}$ths of an inch.

In ten cases of simple cleft palate alone, or of cleft palate combined with only unilateral fissure—

1 case	measured	$\frac{5}{8}$ths to $\frac{6}{8}$ths of an inch.
1 „	„	$\frac{5}{8}$ths „ „
4 cases	„	$\frac{7}{8}$ths „ „
3 „	„	1 inch.
1 case	„	$1\frac{1}{8}$th of an inch.

giving an average measurement of $\frac{7}{8}$ths of an inch.

I have selected the inter-bicuspid point of measurement, as being that in which the relative width in the infantile, compared with the adult jaw, seems to vary least. The increase by expansion of the jaw in this direction amounting to very little comparatively from infancy to adult age in the healthy subject.

It would thus appear that while in the infant there is abnormal *separation*, in the adult there occurs abnormal *approximation* of the parts on each side of the fissure. To a certain extent this approximation of parts may be fortuitous: a misdirection of growth dependant upon the absence of the mesial structures, while the superior maxilla is becoming, as age advances—elongated downwards by the expansion of the antrum. But as the same approximation seems to occur even where only a partial fissure exists,—the cleft being limited to the palate, while the maxillary arch is throughout complete,—there is reason to conclude that it is in some measure to be considered as a reparative, or rather an ameliorative effort on the part of nature towards remedying the defects existing. And such a view becomes practically interesting, as pointing to the probability of a certain amount of assistance likely to be obtained in this manner, by a judicious delay in surgical interference with such cases.

Further, the perfect development of the true maxillaries, indicated by the invariable presence of the canines, is significant of the lesion being one chiefly affecting or originating in the interposed structures; and in the more characteristic cases the disease no doubt is best marked in its effects on the intermaxillary bones. Without homologating any hypothesis advanced on such subjects, this proclivity to irregular or arrested development in these bones —the hæmal spines of the nasal vertebra, as described by Owen— the hæmapophyses of the catacentric vomerine sclerotome, as described by Goodsir,—seems to afford a confirmation of the theory, that the tendency to return to a manifestation of what have been described as archetypal characters; or, on the other hand, to assume an erratic development, becomes greater as we depart from the vertebral centrum. This part of the subject is one, however, which, without mature elaboration of many as yet undetermined facts bearing on it, cannot be treated in either a positive or an exhaustive manner. But in a further acquaintance with those great principles of morphology, of late beginning to be revealed in the vertebrate skeleton, we may expect that the nature of malformation and metrological disease will be presented in a new and more intelligible light.

5. Notes more especially on the Bridging Convolutions in the Brain of the Chimpanzee. By Wm. Turner, M.B., F.R.S.E.

The late Professor Gratiolet, in his elaborate and beautifully illustrated memoir, "Sur les Plis Cérébraux de l'Homme et des Primates," attaches great weight in his differential diagnosis of their cerebral characters to the presence or absence of one or more members of a series of convolutions, which he designates as the *plis de passage*. When present, these convolutions bridge over the external perpendicular fissure of the hemisphere, and connect the parietal and temporal with the occipital lobes. By various anatomists in this country they are called bridging, connecting, or annectent convolutions. In the brain of the Chimpanzee M. Gratiolet states that the first bridging convolution is altogether

wanting; that the second is present, but concealed under the operculum of the occipital lobe; that the third and fourth are superficial.

In his comparison of the brain of the Chimpanzee with the brain of the Orang, he attaches great importance to the absence of the first bridging convolution in the former, and to its presence in a well-marked manner in the brain of the latter ape. In his general *résumé* (p. 98) of the mode of arrangement of the second bridging convolution in the brains of the monkeys of the old world, he states that in them it is constantly concealed under the operculum, and never comes to the surface; whilst the third and fourth connecting convolutions are always superficial.

All anatomists who have inquired into this subject since the publication of M. Gratiolet's memoir agree with him in recognising the superficial position of the third and fourth, and the concealment of the second bridging convolution within the perpendicular fissure in the brain of the Chimpanzee. But with regard to the complete absence of the first bridging convolution in the brain of this ape, evidence has been advanced which proves that M. Gratiolet's statement, although correct in some specimens—as, for example, in the one which he described and figured—yet is not universally applicable.

Thus Professor Rolleston states* that on the right side of the Chimpanzee's brain, in the Oxford University Museum, a well-marked superior bridging convolution came, for a considerable part of its length, nearly or quite to a level with the lobes it connects; and Professor Marshall describes† on the right side of the brain of a Chimpanzee, which he dissected, a rudimentary superior connecting convolution of very small size passing from the outer margin of the lobule of the second ascending convolution outwards, and then bending inwards and backwards across the perpendicular fissure to join the occipital lobe.

Whilst dissecting the brain of a young male Chimpanzee, which was given to me about two years ago by my former pupil, Mr Alfred Pullar, I obtained evidence of a greater extent of variation in the arrangement of the convolutions in this ape than had up to that time, I believe, come under the notice of anatomists. This

* Natural History Review, 1861, p. 211.

† Natural History Review, 1861, p. 309.

brain I shall designate in the following remarks as *A*. By permission of Professor Goodsir I have also had the opportunity of examining two as yet undescribed brains of this animal, both females, in the anatomical museum of the University of Edinburgh. It will be convenient to refer to these as *B* and *C*.

In all three specimens the antero-posterior convolutions of the frontal sub-division of the frontal lobe corresponded so generally in their arrangement with each other, and with the brains of the

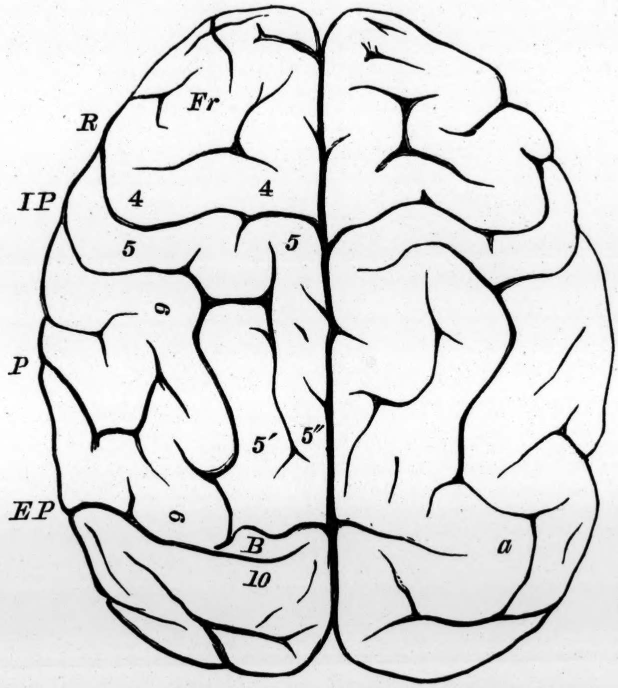


Fig. 1.—Vertex view of the brain *A*. *Fr.* Frontal lobe. *R*, Fissure of Rolando. *I P*, Intra-parietal fissure. *P*, Parallel fissure. *E P*, External perpendicular fissure. 4, 4, Ascending frontal gyrus. 5 5, Ascending parietal gyrus. 5″, Inner, 5′, Outer part of postero-parietal lobule. 6 6, Angular gyrus. 10, Superior occipital gyrus. *a*, Superior annectent gyrus. *B*, Second annectent gyrus.

Chimpanzee figured by Professors Gratiolet and Marshall, that no special description is necessary. In all, the olfactory sulcus was well marked; and in two specimens a triradiate arrangement of the sulci, situated in the outer part of the lobule, was distinct, though in the third specimen (*A*) this regular mode of arrangement did not exist. The ascending frontal (premier pli ascendant) (4 4) and ascending parietal (deuxième pli ascendant) (5 5) convolutions also agreed very closely in their general arrangement;

and in all the specimens the fissure of Rolando (*R*) extended upwards as far as the great longitudinal fissure, and formed with its fellow the sides and apex of a V-shaped figure. The lobule of the second ascending parietal convolution of Gratiolet (postero-parietal lobule—*Huxley*) reached as far back as the external perpendicular fissure (parieto-occipital fissure), and presented a subdivision into an internal (5″) and external (5′) portion; each of which again, though somewhat more strongly marked in *B* than in *A* and *C*, exhibited signs of sub-division into secondary lobules. The bent or angular convolution (pli courbe) (6 6) varied somewhat in its arrangement in the three specimens. In *A* it commenced much lower down in front of the Sylvian fissure than in *B* and *C*. The length of its ascending part, from its commencement to the apex of the fissure, was in the first named $1\frac{1}{10}$th inch, whilst in the others it was considerably less. In all three brains it was partially broken up into smaller convolutions by secondary fissures. In *A* its descending part was directly prolonged into the middle temporo-sphenoidal convolution, as in the brains figured by Gratiolet and Marshall. In *B* and *C* its continuity superficially with this convolution was broken by a cross intersecting fissure. Not only in the brain of the Chimpanzee, but in those of all the apes in which the various parietal convolutions are differentiated, the fissure which separates the angular convolution from the second ascending parietal and its posterior lobule is so clearly marked that it deserves to be recognised by a distinctive term; but as none has as yet been applied to it, I would suggest that it should be called the intra-parietal fissure (*I P*). This fissure commences anteriorly behind the fissure of Rolando, at first ascends almost parallel to it, and then runs backwards and joins posteriorly the parieto-occipital fissure.

In the brain (*C*) the external perpendicular (parieto-occipital) fissure (*E P*) on each side was unbroken by the passage across of either the first or second bridging convolutions, and the opercular edge was as sharp and well-defined as in the brains figured by Gratiolet and Van der Kolk and Vrolik. But in *B*, whilst this arrangement existed in the right hemisphere, the left exhibited an important variation. From the posterior and outer angle of the left postero-parietal lobule a narrow, but clearly-marked convolution (*a*, fig. 2), half an inch long and $\frac{1}{8}$th of an inch wide, arose. It

passed almost transversely inwards, and joined the supero-internal angle of the occipital lobe close to the longitudinal fissure. It was superficial in its entire extent, and consequently bridged across the external perpendicular fissure. From its position and connections it must be regarded as the homologue of the superior connecting convolution of Gratiolet. This brain, therefore, furnishes another example to those already recorded by Professors Rolleston and Marshall of the occurrence of this convolution on one side of the brain of the Chimpanzee, though in the opposite hemisphere to that found in their specimens.

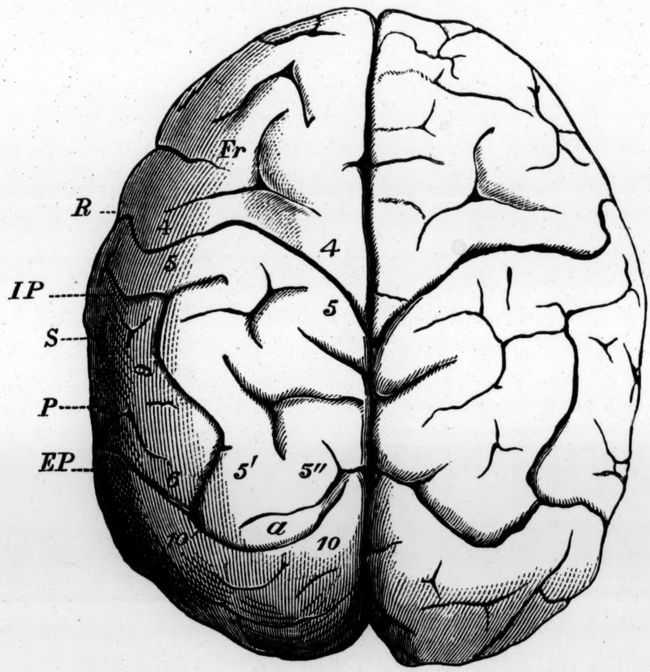


Fig. 2.—Vertex view of brain *B.* The lettering as in Fig. 1, with, in addition, S. Sylvian fissure.

In the brain (*A*) the amount of variation was still more strongly marked. On the right side the postero-parietal lobule gave off from its outer and posterior part a superficial convolution (*a*, fig. 1) $\frac{3}{10}$ths of an inch broad, which was almost immediately joined on its deep surface by a slender process from the superior angle of the bent convolution, the place of junction being concealed by the imperfectly defined occipital operculum. This convolution, then, passed across the external perpendicular fissure, inclined inwards, till it

reached the longitudinal fissure of the cerebrum, of which it formed the boundary for half an inch, and then joined the inner end of the first occipital convolution. A secondary fissure passed for some distance into its substance before it joined the occipital lobe. Throughout its entire extent it formed a very distinct, superficial, first connecting convolution, almost as well marked, indeed, as that figured and described by Gratiolet as so remarkable and distinctive a feature of the brain of the Orang amongst the apes.

On the left side no first connecting convolution existed; but from the superior angle of the bent convolution, where it became continuous with the descending limb, a narrow convolution (*B*, fig. 1), $\frac{1}{5}$th of an inch wide, arose. At its origin it was concealed by the occipital operculum; but almost immediately it became superficial in the parieto-occipital fissure, passed almost transversely inwards, and joined the inner angle of the superior occipital convolution close to the longitudinal fissure. The length of its superficial portion was $\frac{3}{5}$ths of an inch. From its origin it was evidently the second bridging convolution, and in its superficial position it exhibited an arrangement such as has not before been recognised in the brain of the Chimpanzee, and which Gratiolet, indeed, had not met with in any of the numerous brains of the Old World apes which he had examined.

The convolutions of the occipital lobe presented no variation in arrangement calling for special remark. They were joined, in the usual way, by the third and fourth superficial bridging convolutions proceeding from the temporo-sphenoidal lobe.

In the disposition of parts about the Sylvian fissure, the brains *B* and *C* corresponded closely to those figured by Professors Gratiolet and Marshall, but in the brain *A* an arrangement prevailed such as has not yet been described in the brain of the Chimpanzee. The anterior lip of the Sylvian fissure was as usual sharp and well-defined, but the posterior marginal convolution (*pli temporal supérieur*), instead of forming the posterior boundary of this fissure in its entire extent, became gradually narrower as it ascended, and at the same time receded from the surface. As a consequence, its upper end was entirely concealed, the Sylvian and parallel fissures became continuous superficially with each other, and the ascending and descending limbs of the bent convolution formed the anterior

and posterior lips of the combined Sylvian and parallel fissures. The remarkable superficial continuity of these fissures might be apt, on a hasty glance, to lead to the impression that the Sylvian fissure mounted much higher on the outer surface of the hemispheres than is usual, but what at first sight seemed to be the upper end of the Sylvian was really the upper end of the parallel fissure, as was at once proved by separating the ascending and descending parts of the bent convolution from each other, when the upper concealed end of the Sylvian fissure became visible. A similar arrangement to that just described has been stated by Gratiolet (p. 29) sometimes to occur in the brain of *Cercopithecus Sabæus*.

The median or central lobe (Island of Reil) consisted on the left side of five short and almost straight convolutions, none of which possessed any great size, but on the right side only four were visible. The fissures which separated these gyri from each other were short and shallow. The gyri radiated outwards and backwards from the locus perforatus anticus. The most anterior joined superficially the inferior frontal gyrus; the rest were separated by

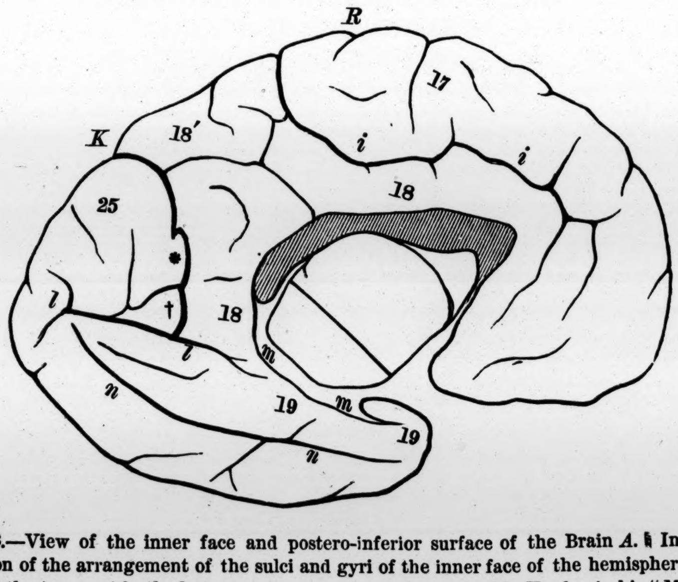


Fig. 3.—View of the inner face and postero-inferior surface of the Brain *A*. In my explanation of the arrangement of the sulci and gyri of the inner face of the hemisphere, I have adopted the terms with the letters and numerals employed by Mr Huxley in his "Memoir on *Ateles Paniscus*" (*Proc. Zoological Soc.* 1861), and by Mr Flower, in his "Memoir on the Posterior Lobes of the Cerebrum, in the Quadrumana" (*Phil. Trans.* 1862).

a deep groove from the convolutions, which formed the anterior lip of the Sylvian fissure. The island was deeply situated within the

fissure of Sylvius, and excepting a small part of the most anterior gyrus, where it joined the inferior frontal, was completely concealed so long as the lips of the fissure were *in situ*.

The brain *A* is the only specimen on the inner and tentorial surfaces of the hemisphere of which I have been enabled to study the arrangement of the fissures and convolutions. The calloso-marginal sulcus (*i i*) commenced anteriorly in front of the anterior end of the corpus callosum, and extended uninterruptedly backwards. When opposite the commencement of the posterior third of the corpus callosum it bifurcated,—one branch ascended and reached the margin of the great longitudinal fissure, the other ran backwards and joined the internal perpendicular fissure. From the calloso-marginal sulcus a few secondary fissures extended upwards and downwards into the marginal (17) and callosal (18) convolutions.

The internal perpendicular (occipito-parietal) fissure (*K*), slightly convex forward, was continuous at the upper margin of the inner face with the external perpendicular fissure, whilst inferiorly, it joined the calcarine sulcus (*l l*). Proceeding from its posterior lip, two connecting convolutions ran at once into the fissure; one, (*) deeply placed, except at its origin, mounted upwards and outwards, and joined the deeper aspect of the postero-parietal lobule. Its concealed part exhibited an indication of subdivision into two gyri. The other, or inferior annectent gyrus (†) partly projected into the perpendicular, and partly into the calcarine fissure, and joined the lower portion of the quadrate lobule. The dentate sulcus (*m m*) was well-marked, and at its lower end was prolonged into the recurved part of the uncinate gyrus (19). The calcarine sulcus (*l l*), which possessed great depth, commenced posteriorly in a bifurcated extremity, the two limbs of the forks being almost equal in length. It extended forwards close to the dentate sulcus, but did not quite join it, so that the callosal (18) and uncinate (19) gyri were continuous with each other in front of its anterior extremity. Within the calcarine sulcus two small gyri were found. One sprang from the floor of the fissure, and evidently corresponded to the calcarine gyrus, described by Mr Flower as so well developed in the brain of *Cercopithecus;* the other and larger arose from the internal occipital lobule (25) which formed the roof of the sulcus; it projected towards the calcarine gyrus: anteriorly it became continuous with

the quadrate lobule, and the inferior annectent gyrus, and posteriorly it turned round the upper branch of the sulcus, and joined the supero-occipital gyrus. The collateral sulcus (*n n*) reached almost the entire length of the tentorial aspect of the hemisphere, and although neither so deep, nor extending so far back as the calcarine sulcus, yet reached in front almost as far as the tip of the temporo-sphenoidal lobe. Some small secondary fissures proceeded from it. The internal occipital (25) and quadrate (18′) lobules were well seen, and the latter was considerably larger than the former.

The three specimens of the brain of the Chimpanzee just described prove that the generalisation which Gratiolet has attempted to draw of the complete absence of the first connecting convolution, and the concealment of the second, as essentially characteristic features in the brain of this animal, is by no means universally applicable. In only one specimen did the brain, in these particulars, follow the law which Gratiolet has expressed. As regards the presence of the superior bridging convolution, I am inclined to think that it has existed in one hemisphere, at least, in a majority of the brains of this animal which have up to this time been figured or described.* The superficial position of the second bridging convolution is evidently much less frequent, and has as yet, I believe, only been seen in the brain (*A*) recorded in this communi-

* But few specimens of the brain of the Chimpanzee have as yet been figured or described. In that figured by Tyson, only the base and an internal view of the brain are given. In the brains figured and described by Gratiolet, and Van der Kolk and Vrolik, and in my brain (*C*) no superior bridging convolution existed. In the brains described by Rolleston and Marshall, as well as in the brains *A* and *B* now described, it is precisely stated that it was present in one hemisphere. In the brain figured by Tiedemann (*Phil. Trans.* 1836), from a specimen in the Hunterian Museum, London, it is apparently present in the left hemisphere, though it is not referred to in the description; and from the drawing of a careful cast of the brain dissected by Dr Macartney (*Trans. Royal Irish Acad.* 1843), it seems probable that the first bridging convolution existed in his specimen.

Addendum, May 5.—Since the above paper was read, a fine young male Chimpanzee has been purchased by Professor Goodsir for the Anatomical Museum, the brain of which I removed and examined. In both hemispheres the parieto-occipital fissure was unbridged, and the opercular edge of the occipital lobe was as sharp andwell defined as in my brain (*C*), or in the specimen figured by Gratiolet.

cation. The a-symmetrical arrangement of the convolutions in the two hemispheres which previous observers have referred to in their descriptions, is also well illustrated in these specimens. The higher differentiation of the cerebral convolutions in the Chimpanzee over that of the lower apes affords room for a greater amount of variability of arrangement in it than in them. Hence, in depicting the brain of this animal, just as in the representation of its face and figure, every drawing should be a portrait, and every description whilst embracing the great general outlines in which all the specimens probably agree, should yet indicate the special modifications in construction exhibited by the individual.

6. On the Theory of the Refraction and Dispersion of Light. Part I. By Alfred R. Catton, M.A., F.R.S.E., Fellow of St John's College, Cambridge, Assistant to the Professor of Natural Philosophy in the University of Edinburgh.

Supposing the phenomena of light to be caused by the indefinitely small vibrations of a highly elastic medium pervading space, it is a simple problem to determine the motion of such a medium *in vacuo*, or in space, where matter does not exist, as in these cases the problem is reduced to the determination of the motion of a *homogeneous* elastic medium.

On proceeding, however, to investigate the motion of the ethereal medium in crystals, for the purpose of accounting for the phenomena of crystalline refraction, the question arises, whether there is an action between the material molecules and the etherial medium. In other words, are the laws of the refraction of the ether within crystals, independent of the existence of material molecules, so that the ether may be treated as a single elastic medium, or are the phenomena of crystalline refraction produced, wholly or partially, by a direct action between the material molecules and the ether?

It is necessary, therefore, to consider at the outset, whether there are any physical facts which throw light on this question. For this purpose the observations of Sir David Brewster, De Senarmont, Des Cloizeaux, Mitscherlich, and others, are discussed at length in the paper.

The discoveries of Sir David Brewster show that the optical properties of crystals are connected with the arrangement in space of the material molecules of which they are built up. Thus when the material molecules are symmetrically arranged with respect to three planes at right angles to another (as in the prismatic system), or where there is only one plane of symmetry (as in the oblique system), or none (as in the anorthic), there are two optic axes. But when they are symmetrically arranged about one line as an axis, there is only one optic axis which coincides with the axis of symmetry of the crystal. In the cubic system, which is symmetrical in every direction, every straight line becomes an optic axis.

Again, in quartz and dextro- and lævo-tartaric acids (as observed by Pasteur), the direction of rotation of the plane of polarization is to the right or left according as the hemihedral forms which occur on crystals of these substances turn to the right or left. Here, then, a want of symmetry in the arrangement of the material molecules is connected with a want of symmetry (so to speak) in optical properties.

The bearing of the experiments of De Senarmont, Des Cloizeaux, and others, is then discussed, and it is shown that, in general, whenever and from whatever cause the arrangement of the material molecules is changed, the optical properties are also changed. The influence of heat and pressure on crystalline refraction is well-known. Thus in a rhombohedron of calcite, increase of temperature alters the angles between the faces, making them approach more nearly to a cube, and at the same time the extraordinary refractive index is increased. A similar observation has recently been made by Fizeau in quartz. From the facts brought forward in this paper, it is concluded that the ether within all bodies is of the same nature as *in vacuo*, and that the optical properties of crystals are caused entirely by the direct action of the material molecules on the ether. Of course the action which the ether exerts at a given point within a crystal is not, as *in vacuo*, the same in every direction. For in crystals of the prismatic system, the action of the material molecules is different in different directions; in other words, it tends to compress the ether more in one direction than in another, and in consequence the resistance of the ether to compression must also be different in different directions.

The great defect in the theories of crystalline refraction hitherto proposed, viz., the theories of Fresnel, Cauchy, Neumann, Macullagh, and Green, is the neglect of the action of the material molecules. In these theories the ether within crystals is supposed to possess special properties different from those which it possesses *in vacuo*, such as possessing different degrees of elasticity in different directions; the ether in every body being supposed to possess an elasticity peculiar to itself. In none of these theories are any considerations advanced to show how the ether might be supposed to have acquired the special properties which it is found necessary to assume that it possesses, in order that these theories may account for phenomena. So that, even if they were satisfactory in other respects, an important desideratum would still be left. A few remarks are then made on the question whether the ether is a *continuous* or *discontinuous* medium. In the present paper the general equations of motion are obtained on both suppositions. *In vacuo* the equations of motion are known to be of the same form whichever supposition is adopted.

With respect to the molecular action between matter and the ethereal medium, it is supposed to be sensible at only very small distances. That this is true, in general, for molecular forces, is shown by such facts as the following:—When a solid, as a piece of marble, is reduced to powder, no amount of pressure will make the powder again cohere into a solid mass. Two *clean* surfaces of lead may be made to cohere, but not if there is the slightest film of oxide. There are a number of other facts of the same kind. The height to which the fluid rises, or is depressed, in a capillary tube is independent of the thickness of the tube. Also, to take the case of water—if the thinnest film of grease be present in the tube, the water is depressed instead of elevated, showing that the sphere of action of the molecular forces of the glass on the water is less than the thickness of the thinnest film of grease. The strength of a wire, also, is dependent only on its *section*. Also, if we take a crystal of Iceland spar, and reduce it by cleavage, or otherwise, to as small dimensions as possible, it is found that the crystals successively obtained are in every respect similar in their optical properties to the original crystal. The portions of the crystals, therefore, removed by cleavage, have no effect on the optical pro-

perties of the minute crystal ultimately obtained; and as crystals of quartz and other substances have been obtained of almost microscopic dimensions, but still possessing all the properties of large crystals of these substances, we see that the motion of the ether at any point of a crystal is only affected by the material molecules which are within extremely minute distances of that point.

Again, there is no dispersion of light *in vacuo*, or in space. In order that this may be the case, that is, in order that rays of all wave lengths may be propagated with the same velocity, it can be shown that the action exerted by the parts of the ether on each other can only be sensible at very small distances.

In obtaining the equations of motion, it is supposed that the motion constituting light is transversal to the direction of propagation, which is equivalent to supposing that the ether is incompressible with respect to the forces called into action in the propagation of light, or that the motion of the ether takes place without change of density.

The arguments in support of the hypothesis of transversal vibrations, to which Fresnel was led by physical considerations, founded on the non-interference of rays polarised in planes at right angles to each other, are so well known, that it is not necessary to enter into their discussion. Suffice it to say, that "if the simplicity of a theory which conducts us through a multitude of curious and complicated phenomena, like a thread through a labyrinth, be considered to carry the stamp of truth, the claims of the theory of transverse vibrations seem but little short of those of the theory of universal gravitation" (Stokes "On the Dynamical Theory of Diffraction," *Cam. Phil. Trans.*, vol. ix. p. 2). As in other theories, the squares of the displacements of the elements of ether from their positions of equilibrium are neglected.

The following Gentlemen were balloted for and admitted Fellows of the Society:—

Adam Black, Esq.
Alexander Macduff, Esq. of Bonhard.
Thomas Constable, Esq.
Dr James Dunsmure, Pres. R.C.S.
Dr Arthur Mitchell.

The following Donations to the Library were announced:—

Journal of the Scottish Meteorological Society. New Series, No. 9. Edinburgh, 1866. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society of London. Vol. I. No. 1. 1866. 8vo.—*From the Society.*

Journal of the Linnean Society of London. Vol. IX. No. 36. (Botany). 8vo.—*From the Society.*

Eighth Detailed Annual Report of the Registrar-General of Births, Deaths, and Marriages in Scotland. Edinburgh, 1866. 8vo. —*From the Registrar-General.*

Monthly Return of the Births, Deaths, and Marriages registered in the eight principal towns in Scotland. January 1866. 8vo.—*From the Registrar-General.*

Rendiconto delle Tornate e dei Lavori dell' Accademia di Scienze Morali e Politiche. Anno 4. 1865. 8vo.—*From the Royal Society of Napoli.*

Entstehung und Begriff der naturhistorischen Art, von Dr Carl Nägeli. Zweite Auflage. München, 1865. 8vo.—*From the Author.*

Induction und Deduction, von Justus von Liebig. München, 1865. 8vo.—*From the Author.*

Rede gehalten in der öffentlichen Sitzung der K. Akademie der Wissenschaften, am 25 Juli 1864, zur vorfeier des allerhöchsten Geburts und Namens-Festes Sr. Majestät des Königs Ludwig II. von Bayern. Von Dr Georg Martin Thomas. München, 1864. 4to.—*From the Author.*

Chinesische Texte zu Dr Johann Heinrich Plath's Abhandlung. München, 1864. 4to.—*From the Author.*

Magnetical and Meteorological Observations, made at the Government Observatory, Bombay, in the year 1863. Bombay, 1864. 4to.—*From the Observatory.*

La Repubblica di Venezia e la Persia, per Guelielmo Berchet. Torino, 1865. 8vo.—*From the Italian Government.*

Relazione della direzione tecnica alla direzione generale delle strade ferrate dello state. Torino, 1863. 4to.—*From the Italian Government.*

Monday, 5*th March* 1866.

In the absence, from illness, of Sir David Brewster, the chair was taken, *pro tem.*, by Professor Tait, on the motion of Professor Balfour.

In delivering the Keith Medal to Principal Forbes, Professor Tait said—"The suddenness of this summons, and my consequent total want of preparation, may well excuse me if I fall short of what is due to the Society or to Principal Forbes on this occasion. Nothing, however, could be more agreeable to myself than to perform such a duty to him who was my earliest instructor in the science I now profess. Principal Forbes has already obtained this prize, and has, during a long and active career of investigation, over and over again merited it. As one of his unrewarded works which may be taken as a type of their value, I may merely mention his Theory of Glacier motion, which, in spite of ignorant and invidious criticism, still remains the true statement of the observed phenomena—all it pretended to be.

"Happily, with reference to the paper which has won the honour I have to confer, I am provided with the opinion of perhaps the greatest living authority on the subject of Heat, Professor W. Thomson of Glasgow. As one of your secretaries, I had obtained it from him, with the view of its being incorporated in the address which ill health has prevented our President from delivering on the present occasion. The reading of this is all that is necessary to prove to you how justly the medal has been merited.

"Principal Forbes' experimental investigation of the thermal conductivity of iron has enlarged our knowledge of the properties of matter with information, which is not only of extreme interest and

importance in the deeper speculations of natural philosophy, but of very great practical value. Other experimenters had given tolerable approximations to the *relative* conductivities of different metals, but had either not attempted, or had most notably failed, to measure the conductivity of any one metal. The problem which had thus proved so difficult has been first solved by Forbes. The absolute value which he has found for the conductivity of iron is well guaranteed for accuracy by the full and satisfactory statement of the principle and details of his investigation, which has been published in the 'Transactions.' Its close agreement with Ångström's subsequent determination, by a very different method, also trustworthy, proves the agreement in the conductive quality of the specimens of iron used by the two experimenters; but is not required to confirm the results of either.

"The method by which Forbes analyses the circumstances concerned in the transmission of heat along a bar of which one end is maintained at a high temperature, is remarkable, no less for the ingenuity shown in its invention than for the thorough and vigorous working out of the laborious processes of experiment and of reduction, both graphic and by calculation, which it involves. The manner in which, from that analysis, Forbes discovered the *variation* of conductivity, due to variation of temperature, along the bar, is very striking. The final deduction of the varying value, through a wide range of temperature, of the absolute measure of the thermal conductivity of iron, constitutes a very important contribution to physical science."

After the delivery of the Medal, Principal Forbes took the Chair as senior Vice-President.

The following Communications were read:—

1. On Some Capillary Phenomena. By Professor Tait.

This communication was intended to illustrate by experiments with the solution of glycerine and oleate of soda, devised by Plateau, the mode in which a soap-bubble is detached as a closed

shell from the mouth of a funnel; the mode in which two bubbles unite; and the process of cutting one into two or more.

A statical investigation of the form of an unclosed film, blown with coal gas, was given (the kinetic problem presenting very grave difficulties), and the results were shown to be in accordance with observation, so far as the eye can follow the rapid change which takes place in the neck of the film just before the closed bubble is detached.

Professor Tait called attention to the exquisite manner in which the molecular motions in the film may be exhibited by employing the posterior surface of a large bubble as a concave mirror to form a small bright point from a beam of parallel rays, and receiving on a screen the light diverging from this point after it has passed through portions of the anterior surface.

He also noticed that the spectrum of the reflected light shows very effectively the phenomena of interference, supposed by Von Wrede to account for the dark lines in the solar spectrum.

2. On Functions with Recurring Derivatives. By Edward Sang, Esq.

In a previous paper, it was pointed out that the characteristic problem of the third branch of the higher calculus, is to discover the relation between the primary variable and its function, when the relation subsisting between the function and its derivative is known. The present paper treats of the solution of the simplest case of this general problem, that in which the function is equal or proportional to its derivative.

The proposition in hand is naturally divided into cases, according to the order of derivation: The first two of these can, by well-known artifices, be brought under the dominion of the integral calculus, and their relations can therefore present nothing new. But for the sake of the continuity of the treatment, and of certain relationships which otherwise could not have been so well explained, they have been discussed in the paper. When we inquire into the nature of the function which is equal to its own first derivative, we arrive at the exponential function, and at the basis of Neperian Logarithms of this function e^t, the development is

$$1+\frac{t}{1}+\frac{t^2}{1\cdot 2}+\frac{t^3}{1\cdot 2\cdot 3}+\frac{t^4}{1\cdot 2\cdot 3\,4}+\&c.$$

and it is shown that the fundamental recurring functions of any higher order, as the n^{th}, are obtained by taking each n^{th} term of this development.

When each alternate term of the series for e^t is taken, we obtain a function which is equal to its own second derivative; of this function there are two varieties, according as the terms contain the even or the odd powers of the primary. If the value of the primary be represented by abscissæ, and the corresponding values of the function be indicated by ordinates, we obtain two curved lines, one of which is the catenary, and the other, a line which may be called the companion to the catenary; these two lines do not meet each other.

If we take each third term of the development of e^t, we obtain recurring functions of the third order; of these there are three varieties, according to the term with which we begin. When the values of these three functions are represented by ordinates, there result three curved lines which intersect each other, and it is shown that their intersections take place on ordinates at equal distances from each other, the lines being, as it were, plaited upon each other. As the value of the primary is augmented, the interval between the curves, as measured on an ordinate, generally diminishes, and the three lines soon become so close as to be undistinguishable in a drawing of ordinary size. For negative values of the abscissæ, the curves separate more and more from each other. The distance between the ordinates, on which these intersections take place, is an important feature of the ternary functions; it bears a certain relation to the circumference of a circle of which the radius is equal to the linear unit, and is susceptible of very easy computation.

A very remarkable property of the lines representing these ternary functions is this, that if an equilateral triangle be placed in a plane perpendicular to the plane of the paper, and passing through one of the ordinates in such a way as that the three corners of the trigon may have the points of the three curves for their projections; and if the ordinate be supposed to be displaced along the line of abscissæ at a uniform rate, the trigon will turn round also with a uniform velocity, and its side decreases or increases in continued

proportion, according as the direction of the motion of the ordinate is toward the + or − side of the absciss.

When each fourth term of the series for e^t is taken, we obtain recurring functions of the fourth order; of these there are four varieties, distinguishable into two groups according as they involve odd or even powers of the primary. The curved lines representing the functions of the even powers accompany each other, crossing and recrossing on ordinates at equal intervals, the middle line between them being a modification of the catenary. The lines representing the functions with odd powers also accompany each other on ordinates midway between those of the previous pair. The distance between these ordinates corresponds to the value of π, the ratio of the circumference to the diameter of a circle; and as the computation of this value is easily made, we have a new determination of π, independent of the theory of the circle. The intersections of the curves of even with those of odd powers, are not on ordinates at equal distances.

The quaternary functions are notable on this account, that by addition, they gave the catenarian—by subtraction, the circular functions.

When we proceed to the fundamental recurring functions of higher orders, we find that the interruptions of the representative curves no longer occur on equidistant ordinates, although certain compounds of them present the plaited appearance of the ternary lines; and it is noteworthy, that then the loops widen as we proceed towards the + end of the line of abscissæ.

3. The World as Governed by Law, Teleologically considered. By R. S. Wyld.

Mr Wyld stated that he considered the philosophic treatment of this subject important, as there existed a great amount of loose, ill-digested opinion in the public mind regarding it, and possibly also in the minds of many men of science.

The first object of the paper is to direct attention to the fact of the existence of general laws, alike in the physical and in the moral world; to consider these as designed for the benefit of the

human race; and to enforce the duty of reviewing them as the appointed paths to human happiness and progress.

Mr Wyld showed that the doctrine is not only not necessarily connected with what is called infidel opinions, but, on the contrary, is far more naturally allied with the belief in a supreme Ruling Intelligence.

In the prosecution of the subject, he first directed attention to physical law, showing, in particular, in what manner he believed the law of attraction to have operated in bringing about the present structure of the earth, and to be operating in a similar way in the case of some of the planets.

Regarding the mental or moral world, the writer showed that the entire social system was compacted, and kept in life and energy, by virtue of the various appetites, desires, emotions, and passions by which man is influenced.

The conclusion to which the writer is led, in considering this part of the subject is, that it is unwise and in vain to talk of repressing the instinct which leads man to expect special instances of Divine favour. The instinct is a strong and universal one implanted in us, doubtless for wise and useful ends. It would seem the part of wisdom, then, rather to regulate than to extinguish it; and this can only be done safely, by showing that the *laws of nature* are the *special, just*, and *wise methods appointed by the Ruler of the world for dealing with man*, and as such, that they are to be reverenced, submitted to, and obeyed.

4. Description of *Pygopterus Greenockii* (Agassiz); with Notes on the Structural Relations of the genera *Pygopterus, Amblypterus* and *Eurynotus*. By Ramsay H. Traquair, M.D., Demonstrator of Anatomy in the University of Edinburgh. Communicated by W. Turner, M.B.

In this paper a detailed description is given of a species of Pygopterus (*P. Greenockii*) from the carboniferous shales of Wardie, Mid-Lothian, which was named by Agassiz, but without any figure or description, beyond the mention of the fact that the scales of the

anterior part of the trunk are higher than broad, a circumstance distinguishing it from all the other species of this genus.

According to specimens exhibited by the author, the scales are of different forms on different parts of the body, being very minute, and nearly equilateral along the belly; the fins are large, and the dorsal is placed so far back as to be nearly opposite the anal; the interspinous bones of the azygos fins are well developed, and there are traces of vertebral apophyses, but none of vertebral bodies. On the top of the head are shown the parietal, mastoid, frontal, post-frontal, and prefrontal bones, with a single nasal forming a projection above the mouth. On the side of the head, the operculum, suboperculum, superior maxillary bone and lower jaw are distinctly recognisable, with a large triangular plate, covering the cheek above the upper jaw bone, and smaller ossicles around the orbit, which is placed very far forwards. The broad superior maxillary bone is beveled off for the orbit in front, to a narrow point which comes in contact with a small intermaxillary situated below the nasal and prefrontal bones. The teeth are conical and of two sizes, large ones alternating with small. The branchiostegal apparatus consists of numerous narrow flattened plates, and the shoulder girdle shows the supra-scapular, scapular, and coracoid bones, with a triangular plate in front of the lower end of the coracoid, analogous to a similar plate in the recent Polypterus.

A comparison was made between the osteology of the head in Pygopterus and in Amblypterus, showing the very intimate correspondence in the form and arrangement of the bones in those two genera; and the appearances in both were then compared with the structure of the skull in the recent Lepidosteus and Polypterus.

The general structure of Eurynotus was then noticed, and several of its facial bones described, together with the peculiar rounded teeth with which the jaws and palate are furnished. The opercular apparatus and superior maxillary bone differ considerably in form from those in Amblypterus, and still more marked is the difference in the shape of the teeth; but the two genera agree in the form and arrangement of the branchiostegal plates and in the general structure of the fins and scales. A specimen in the St Andrews Museum, shows distinctly that there were two rows of fulcral scales along the anterior edge of the dorsal fin, at least of Eurynotus.

In regard to classification, it was shown that Pygopterus and Amblypterus must be placed close together in the same family of "Palæoniscidæ," as already done by Vogt (*Zool. Briefe* II. Band s. 133), a family including the so-called "Lepidoidei Heterocerci," with the addition of *Pygopterus*, *Acrolepis*, and their allies, formerly classed as "Sauroidei;" the distinction between Lepidoids and Sauroids having been long ago shown to be artificial. (Müller—*Ganoiden*—Abhandl. Berl. Acad. der Wissenschaften, 1844.) As to the position of Eurynotus, and whether it should remain with Amblypterus and Palæoniscus, or be transferred to the same family with Platysomus and the Pycnodonts, as has been recently done by Dr Young (*Proc. Geol. Soc.* London, Feb. 1866), the author is of opinion that for the present it should remain in the former family, although considered as a member of the group of Palæoniscidæ, it is certainly a very aberrant form.

The following Gentleman was balloted for and elected a Fellow of the Society:—

Dr Patrick Heron Watson.

The following Donations to the Library were announced:—

Pinetum Britannicum. Parts XIV. XV., fol.—*From Charles Lawson, Esq.*

Proceedings of the Royal Geographical Society of London. Vol. X. No. 2. 8vo.—*From the Society.*

Proceedings of the Royal Society of London. Vol. XV. No. 81. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society of London. Vol. I. (New Series). No. 2. 8vo.—*From the Society.*

Geology of the North of Scotland. By James Nicol, F.R.S.E., &c., Edinburgh, 1866. 8vo.—*From the Author.*

Sketch of the Romantic History of Parallels. By Matthew Ryan, Washington, 1866. 8vo.—*From the Author.*

Proceedings of the Royal Medical and Chirurgical Society of London. Vol. V. No. 3. 8vo.—*From the Society.*

Transactions of the Royal Society of Literature, London. Vol. VIII. Part II. 8vo.—*From the Society.*

Nachrichten von der K. Gesellschaft der Wissenschaften und der

Georg-Augusts-Universitat aus dem Jahre 1865. Göttingen, 1865.—*From the University.*

Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen te Haarlem. T. XXI., St. 2., T. XXII., St. 1-2., T. XXIII. 4to.—*From the Society.*

Monday, 19th March 1866.

Sir DAVID BREWSTER, President, in the Chair.

The following Communications were read :—

1. Observations on the Marine Zoology of North Uist, Outer Hebrides,—(Cœlenterata, Mollusca, Echinodermata, Gephyrea, and Pisces).* By W. C. M'Intosh, M.D., F.L.S. Communicated by Professor Allman.

The surface of the island is less richly supplied with animal life than the ocean, and, indeed, with vegetable likewise. The grass is coarse and stunted, and even the hill tops are boggy; while the sea border has rich crops of Fuci, Laminariæ, and other sea-weeds, and harbours hosts of animals, both vertebrate and invertebrate. The inhabitants seem to take certain of the circumstances in which they are placed to the best advantage. Kelp is manufactured from the sea-weeds; the drift-wood makes the framework of their hovel roofs, and is applied, besides, to many other useful purposes; while fishing is universal. The soil, again, on the eastern side, with a single exception, is cultivated with neither vigour nor profit, the islanders having a tendency to be a pastoral and fishing, rather than an agricultural race.

There are few or no rock pools on the eastern side, but at Paible, on the western, they are common, their rich vegetation affording shelter to Cotti, Wrasses, Shannies, and Mysidæ—animals almost totally absent between tide-marks on the eastern side. On the other hand, the laminarian blades at Paible, beyond low-water mark, do not seem to be so prolific in simple or compound Ascidians—probably because the water is purer and more boisterous. At Loch-

* Every specimen hereafter mentioned was seen by the author.

maddy the blades of this sea-weed are covered with a flocculent, muddy deposit, that appears to be favourable to Ascidian existence; while at Paible they are fresh and clean, there being naught, indeed, but pure sand to deposit on them.

The occurrence of inland seas affords an interesting variety in examining marine life. The most abundant animal species in these is *Littorina tenebrosa*, which clothes the branches of the fuci with its myriad examples, and abounds under stones; while swarms of the young of *Rissoa striata* and *R. ulvæ* speckle the green Cladophora. The common mussel clings by its byssus to the fuci and stones; but no large example was seen in such localities, either living or dead. The hand-net showed that *Mysis chamæleon* and *Idotea tricuspdata* found amongst the sea-weed thickets both food and shelter; and the ubiquitous *Gammarus locusta*, and other sessile-eyed crustaceans, lurked under the stones in thousands, as well as sported in the water. *Carcinus mœnas*, as fierce and wary as when in purer water, was common. Under the stones were numerous groups of the little *Planaria ulvæ*. The sole representative of the swimming jellies was a small medusa, with four lilac loops, like *M. aurita.* Of fishes there were grilse, trout, young gobies, and rough-tailed sticklebacks. It was strange to find, within forty yards of such an inland sea, a true boggy, fresh-water lake, where we had the bold contrast of the white water-lily, cardamine, sparganium, horse-tails, and confervæ, holding the place of the neighbouring fuci, and marine algæ. Instead of the marine fauna before-mentioned, glistening beetles skimmed the surface, water-boatmen, dytisci and cyprides the depths, pond snails, cyclades, and leeches, climbed the water plants, and annelids and larvæ crawled in the brown peaty mud at the bottom.

Of the Cœlenterata, nine were got within tide-marks, the most abundant being *Sertularia pumila.* *Caryophyllia Smithii* swarms at the verge of low water on the eastern side of the island, being attached to rather muddy stones that lie piled over each other, so as to form small caverns, in which the corals hang, grow upright, or project horizontally; they feed voraciously on the salpæ. Amongst the anemones *Anthea cereus* attracts most notice from its curious arborescent habits on the fuci and laminariæ of the creeks at low water.

The only Sertularian found in profusion on laminarian blades from deep water was *S. operculata*, which seemed to thrive best on the west coast of the island. Adhering to a mass of *Tubularia indivisa* from the Minch was a creeping stem, having a series of horny, ringed polyp cells, of a somewhat fusiform aspect, with a short, smooth peduncle, the whole having the appearance of a *Campanularia* (fig. 1). They were only observed after immersion in spirit, so that the tentacles of the polyps could not be counted. *Pavonaria quadrangularis* is not uncommon in the Minch, but I only got a single mutilated specimen. *Lucernaria auriculata* was dredged at Paible. In all, thirteen Cœlenterata were procured from deep water.

Fig. 1.

List of Zoophytes.

Clava multicornis.	Campanularia verticillata.
Hydractinia echinata.	dumosa.
Tubularia indivisa.	fig. 1.
gracilis.	Pavonaria quadrangularis.
Halecium halecinum.	Alcyon. digitatum.
Sertularia rugosa.	Caryophyllia Smithii.
pumila.	Actinia mesembryanthemum.
operculata.	coriacea.
Plumularia catharina.	crassicornis.
Laomedea geniculata.	troglodytes.
gelatinosa.	Anthea cereus.
Campanularia integra.	Lucernaria auriculata.

Thirteen Polyzoa were procured between tide-marks; and it is curious to find that here *Crisia eburnea* forms the pigmy forests under stones, in place of the *Sertularia pumila* of the east coast of Scotland. A very abundant Lepralia in the same region is *L. verrucosa.*

From beyond low-water mark there were thirty-six Polyzoa. In one instance, no less than three cups of *Tubulipora patina* grew one above another. *Crisidia setacea* was very abundant on laminarian roots, forming dense, snowy tufts. More than a third (seventeen) of the total number were Lepraliæ. One of the richest fields for these and other marine productions not destroyed by drying was

the collection of Laminariæ, chiefly from the Monich region, formed at the kelp factory. On a tuft of *Tubularia indivisa* from the deep water of the Minch, two specimens of *Retepora Beaniana* occurred. One of these adhered to the test of an Ascidian in a position which prevented the coralline from following its usual law of having the cells only on the concave side, since, to accommodate itself to circumstances, the Retepora had its cells on the convex side. The latter, however, may be regarded only as a contorted inner or concave side. A small independent Retepora on the same mass presented a peculiarity in having its inner or cellular surface hispid with rather stout, simple spines. The apertures of the cells were round, with a raised tooth on one edge, like the cells of *R. Beaniana.* The outer or smooth side in the various specimens is marked by delicate white lines, which at first sight look like cracks.

List of Polyzoa.

Tubulipora patina.
hispida.
flabellaris.
serpens.
hyalina.
Alecto granulata, *var.*
Crisia eburnea.
denticulata.
geniculata.
Crisidia cornuta.
setacea.
Hippothoa divaricata.
Cellepora pumicosa.
ramulosa.
Lepralia hyalina.
tenuis.
Hassallii.
linearis.
granifera.
auriculata.
punctata.
annulata.
biforis.
Peachii.
pediostoma.
Lepralia verrucosa.
variolosa.
nitida.
unicornis.
Ballii.
ciliata.
spinifera.
immersa.
violacea.
bispinosa.
Membranipora pilosa.
membranacea.
Cellularia ciliata.
scruposa.
reptans.
Flustra membranacea.
Retepora Beaniana.
Salicornaria farciminoides.
Alcyonidium gelatinosum.
hirsutum.
parasiticum.
Flustra hispida.
Bowerbankia imbricata.
Pedicellina echinata.

The island is peculiarly rich in Ascidians, thus affording a marked contrast to the eastern shores of Scotland, where the compound species, and a few solitary ones under stones, are the only repre-

sentatives generally met with between tide-marks. *Aplidium fallax* occurs occasionally in masses fully an inch across. On touching living specimens, the large aperture in the common test leading into the internal cavity was sharply contracted. A group of curious animals (*Amouroucium?*), elevated on long, clavate, hyaline peduncles, and arranged round a common centre, were also got under a stone. The truncated tips of the masses were carunculated, and the polyps of a bright orange hue during life. Numerous specimens of several species of bright orange and reddish orange *Leptoclini* abounded on the stones and fuci; and both *Botryllus* and *Botrylloides* were well represented, many having tadpoles in their masses. A curious thin, greyish-brown species, and a bright ochre-yellow one, occurred at the extreme verge of low water, both having glistening (as if varnished) surfaces, covered with soft spiniform papillæ. A *Clavelina* (fig. 2) was got between tide-marks, of a clavated outline, and

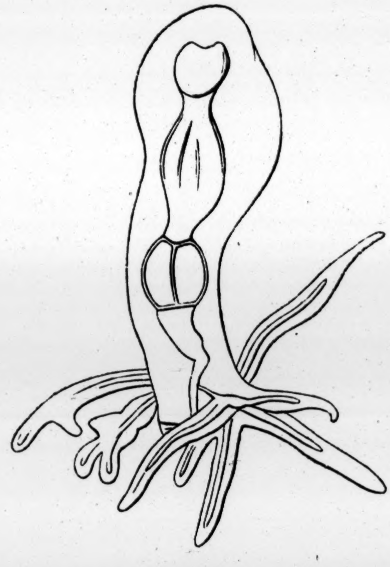


Fig. 2.

with a hyaline test. At the upper part of the animal a dull greyish, muddy mass capped the viscera; below this was a somewhat fusiform, flesh-coloured thorax, irregularly streaked with yellow lines; a swollen bright reddish orange stomach succeeded, marked by regular yellow bands, which on both sides presented a similar appearance, viz., two lateral lines corresponding with the curve of

the region, and a central one, the whole having the shape of the inverted Greek letter ω, and resembling a crown. The visceral region dwindled to a streak before reaching the radiciform prolongations at the base.

The simple Ascidians were represented by *A. intestinalis*, *A. canina*, *A. mentula*, *A. scabra*, and *A. aspersa*. Accompanying the latter were one or two hard, reddish species, that apparently could be classed with neither. From the deep water of the Minch came several Ascidians, slightly adhering to each other by the extraordinary *debris* of shells, mud, and corallines, that surrounded them, yet otherwise solitary and distinct, like *Molgula oculata*. Their orifices were situated on separate fleshy papillæ, the anal having eight streaks of crimson, with intermediate pale lines; the branchial somewhat larger and more prominent, but similarly tinted. *Molgula tubulosa* was occasionally met with on muddy ground (six fathoms) in Lochmaddy. The papillæ were greyish-brown; and when placed in spirit, it speedily cast off its coating of mud and minute shell fragments.

Cynthia rustica and *C. grossularia* are frequent between tide-marks, but not at the extreme verge, for that seems rather occupied by sponges and zoophytes. If a stone having its under surface covered with the former is turned over, death and discoloration of the Ascidians soon take place, although they remain in the same spot as regards the tide. *C. ampulla* (?) was dredged in twelve fathoms on hard ground; it had a tunic covered with sandy hairs, with a clear space on which the two long pinkish apertures were situated. A small specimen allied to *C. tesselata* was also dredged. On the test of a large *A. mentula* from the Minch were several examples of *Cynthia Uistiœ*, new sp. (fig. 3). The largest were about a a quarter of an inch in diameter, globose, and hisped with branched bristles springing from papillæ on a tough greenish tunic. It differs from the Ascidia echinata of Professor Forbes in having four divisions to its branchial orifice, in having no regularity in the arrangement of the bristles, and in their want of radiation.

The countless multitudes of *Salpa spinosa* and *S. runcinata*, in both solitary and aggregate forms, is also a noteworthy fact.

One of the most striking features in the distribution of the mollusca (proper) of the island is the abundance of wood-borers,

and the comparative absence of rock-miners.* The sole examples of the latter lurked between stones that had been fixed together by a laminarian root, in the interstices of the latter, on rocks, in peat, never in an independent tunnel. The drift-wood, again, is almost universally perforated by the Teredo, and many logs are so honeycombed, that they are only fit for firewood, or the cabinet of the naturalist. *Teredo norvagica* and *T. megotara* were the two species observed. The total number of mollusca (proper) recognised was 145; of which sixty-three were Lamellibranchiate, eighty-one Cephalophorous, and one Cephalopodous.

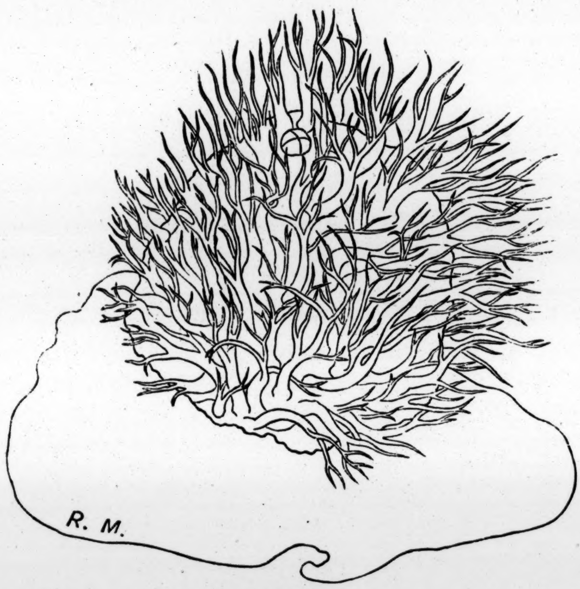


Fig. 3.

Between tide-marks the prevalence of *Trochus zizyphinus* was characteristic. The women and children still gather *Littorina littorea* for sale. The inherent apathy of the islander prevents him taking due advantage of the occurrence of *Mytilus edulis* in the creeks; and he is to be seen fishing with a scrap of limpet or cockle, rather than trouble himself to procure the former for bait. The somewhat rare *Tapes decussata* is met with in the sand at low water. *Fisurella reticulata* and *Emarginula reticulata* are abundant under stones in the same region. *Doris proxima* is common on the floating blades of fuci at low water; and most of the Nudibranchs (17

* The rocks are for the most part composed of *gneiss*.

in number) are in a new field,—one being a new species, viz., *Eolis Lochmaddii :—Body*, rather more than a quarter of an inch in length, pale, translucent, and faintly pinkish on dorsum from viscera. *Tail*, stretching a little beyond the sloped branchiæ, pale. *Oral tentacles*, pale, rather short. *Dorsal tentacles*, generally carried erect, thick, coarsely crenulate, barred with pink, and white at tips. *Eyes*, distinct. *Branchiæ*, at first small and club-shaped, then becoming long and slightly fusiform; processes bent inwards over the dorsum, and tapered towards the tips. *Colour*, pale pink, grained with red; tips with white grains and a few red, capped by a translucent point. It is an active and hardy nudibranch, swimming on the surface, elongating its foot, and throwing it into a goove. It deposited* pale pink ova, as a simple band in transparent mucus.

In the loch, the hard and muddy ground abounded in small cockles, *Venus ovata*, *Crenella decussata*, *Corbula nucleus*, and occasionally the rare *Lima subauriculata*. The most common univalves brought in by the dredge (from four to fifteen fathoms) were Trochi, Lacunæ, Rissoæ, and the curious species resembling *Akera bullata*, but possessing two distinct eyes; the latter animal preferring a hard bottom, not far from mud. *Thracia distorta* and dead valves of *Thracia convexa* were got in company with *Tellina donacina*, *Venus casina*, and *Artemis exoleta* in the same region. The valves of the *Pecten maximus*, cast on shore by winter storms, are still used by the natives for skimming milk and scooping butter. On the western shores of the island the pretty *Phasianella pullus* is common. *Sepiola atlantica* was dredged also at Paible, on sandy ground. A purplish-brown variety of *Elysia viridis*, with many pink and blue specks, was frequently got at Lochmaddy.

List of Mollusca.

Teredo norvagica, *d.*†
megotara.
Saxicava artica.
rugosa.
Mya truncata.
arenaria.
Corbula nucleus
Thracia convexa, *d. v.*†
distorta.
Cochlodesma prætenue, *d. v.*
Solen siliqua.
ensis.
pellucidus.
Tellina donacina, *d. v.*
solidula.
Syndosmya alba.
intermedia.
Scrobicularia piperata.

* August 1865.

† Dead.

Mactra elliptica.
subtruncata.
Tapes decussata.
pullastra.
Venus casina.
striatula.
fasciata, *d. v.*
ovata.
Artemis exoleta.
lincta.
Lucinopsis undata, *d. v.*
Cyprina Islandica.
Circe minima.
Astarte sulcata, *d. v.*
compressa.
triangularis.
Cardium echinatum.
edule.
nodosum.
fasciatum.
pygmæum.
suecicum.
Lucina borealis.
spinifera. *d. v.*
Montacuta ferruginosa.
bidentata.
Kellia suborbicularis.
rubra.
Mytilus edulis.
Crenella discors, in nests and in H. panicea.
marmorata.
decussata.
Nucula nucleus, *d. v.*
nitida.
decussata.
tenuis.
Arca tetragona, *d. v.*
Lima subauriculata.
Pecten niveus, *d. v.*
pusio.
tigrinus.
similis.
maximus.
opercularis.
Ostrea edulis.
Anomia ephippium.
patelliformis.
striata.
Spiralis ?

Chiton discrepans.
Hanleyi.
ruber.
cinereus.
asellus.
Patella vulgata.
athletica.
pellucida.
Acmœa testudinalis.
virginea.
Dentalium entalis.
Fissurella reticulata
Emarginula reticulata.
Trochus zizyphinus.
granulatus, *d.*
Montagui.
tumidus.
cinerarius.
umbilicatus.
majus.
Phasianella pullus.
Littorina littorea.
littoralis.
rudis.
tenebrosa.
Lacuna pallidula.
vincta.
Rissoa Beanii.
punctura.
costata, *d.*
striata and *var.*
parva.
labiosa.
cingillus.
soluta.
ulvæ.
Skenea planorbis.
Turitella communis.
Aporrhais pes-pelicani.
Eulima distorta.
Odostomia eulimoides ?
Natica nitida.
pusilla.
Lamellaria perspicua.
Purpura lapillus.
Nassa reticulata.
incrassata.
Fusus ? young.
Buccinum undatum.
Trophon muricatus.

Mangelia turricula.
Cypræa Europœa.
Cylichna cylindracea.
truncata.
obtusa.
Tornatella ? young.
Akera bullata ? with eyes.
Philine scabra, *d.*
punctata.
Doris tuberculata.
repanda.
aspera.
proxima.
bilamellata.
Doris pilosa.
Goniodoris nodosa.
Ægirus punctilucens.
Polycera quadrilineata.
ocellata.
Doto coronata.
Eolis lochmaddii, *n. s.*
gracilis.
olivacea.
aurantiaca.
cingulata.
Farrani.
Elysia viridis, *var.*
Sepiola atlantica.

Thirteen Echinoderms were dredged or procured between tide-marks, besides a new species of Astrophyton, and a new Synapta. With regard to the *Astrophyton Elizabethæ*,* new sp., fig. 4, it

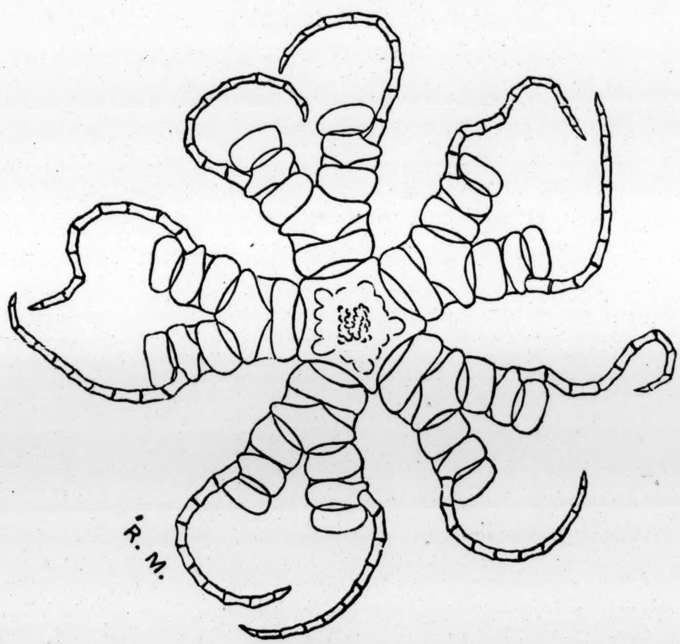


Fig. 4.

is curious that no example of the genus has been found in Britain since the publication of Professor Forbes's work.† It was

* Named after a zoological benefactress.

† Rev. A. Norman, *An. Nat. Hist.*, Feb. 1865. Professor Duns, however, intimated that a specimen of *A. scutatum* had been procured from Shetland since the above-mentioned period by the late Dr Fleming, and was now in the Free Church College Museum.

dredged in six fathoms, on mud and shell gravel. *Body*, somewhat pentagonal, of a pale-flesh colour, here and there slightly grained with red; having regular markings, roughly granulated, and with the margins modified so as to fit the bases of the five rays. The first joint of each of the latter is nearly plano-concave, minutely grained and frosted (in spirit). Between this and the body is a biconvex, ligamentous connection. The next joint is somewhat lozenge-shaped, presenting a central projection, and two slightly curved articular surfaces to the first joint, and a longer process and two more extensive articular surfaces (also curved) on the distal side, each of the latter articulating with a division of the bifid arm beyond. Viewed dorsally, it has thus no less than four articular ligaments. The limbs usually separated at the joint between this and the first segment. A transverse section of an arm at its base showed aborally an arched outline, orally a flattened, so that it was somewhat D-shaped, with a perforation in the centre. Two symmetrical muscular bundles were placed over each of the larger joints inferiorly. The first joint of the secondary arm is of an irregular rhomboidal shape, being widest towards its outer edge, and with the deepest curve on its proximal side; the second, of an irregular lozenge-shape, pointed on both proximal and distal edges, especially the latter, the distal apex being on the outer side of the middle line, the short outer curve thus formed giving rise to the long, jointed limb. The last joint presents a somewhat plano-concave outline on its dorsal surface, the concavity being proximal, and articulating by means of a biconvex ligament with the preceding segment. From the outer side and shorter curve of the second last segment springs, as before mentioned, a long, delicate, jointed arm of ten gradually diminishing pieces, like the skeleton of a vertebrate tail. The segments of these are (in spirit) finely grained, and frosted (after the manner of several Lepraliæ), like the larger segments, and have also microscopic spikes near the junctions, directed distally. Along the ventral surface of these slender armlets, after preservation in spirit (which blanched the rest), were numerous dull, reddish, minute tubercles, apparently imbedded in the tough membrane that was present on this surface. All the arms and their branches were coloured, during life, of a beautiful purple lake, a slightly paler portion being in the centre dorsally.

The hard parts of the animal were densely calcareous, and the disc seemed quite solid. On the under surface was a bulky, soft mass, of a reddish-brown hue, which covered the central disc, and extended outwards over the bases of the arms. Microscopically this consisted of a rich cellulo-granular structure, that might have been the *debris* of ova. The mass readily separated from the under surface of the body and arms, but left a membranous coating which adhered very closely to the edges of the limbs, so that it seemed a fixed process. In this tough, translucent membrane were many minute calcareous scales, with a concentric structure, like those of a cycloid fish. The oral surface, after removal of the soft mass, had a wide circular opening, with several tooth-like processes projecting inwards from the circumference.

Imbedded in the soft mass last mentioned, and partly projecting outwards, was a curious crustacean parasite, of a mottled crimson colour, when fresh (fig. 5).

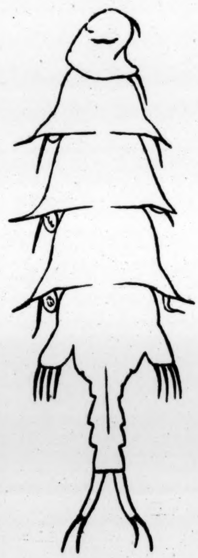


Fig. 5.

The occurrence of *Synapta Galliennii* (Herapath),* a species hitherto only procured from Guernsey, is interesting, and shows how cautiously deductions as to the distribution of marine animals ought to be made. Some of the specimens, though imperfect, measured between 2 and 3 inches, of a pale pinkish or flesh colour, clouded by the dark intestine. Interspersed amongst the spicula were numerous circular, papilliform, grained rings of a brownish-red colour. The specimens agreed in most respects with Dr Herapath's description, but the anchors and anchor plates seem to be more than "serrated," since both are studded over with groups of microscopic spikes and granules, which impart to them a rough, corroded aspect, very characteristic when compared with the succeeding species or *S. digitata*.

Synapta Buskii,† new sp.—Two, about an inch in length, were dredged (nine to ten fathoms) on a bottom of muddy clay in Loch-

* Quart. Jour. Micros. Soc., January 1865.

† Named after Professor G. Busk, London.

maddy. It is a most translucent species, of a pale flesh colour, with the plates and anchors visible as distinct glistening points under a lens, and having five longitudinal muscular bands. One adhered to the cover of a table during life, and could not be taken off without serious mutilation. The intestine is dull yellowish. Both had eleven tentacles, each of which apparently had five divisions, though I am not certain of these figures, since they were minutely examined after immersion in spirit, and then only the terminal and two adjoining divisions of the arms were distinct. The plates and anchors were identical throughout in both examples, and very characteristic (fig. 6). The plates have a somewhat hexagonal out-

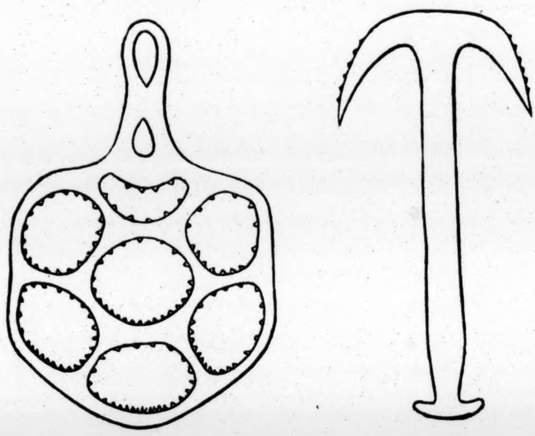


Fig. 6.

line, with a long process, like a handle, and are perforated by a central and six surrounding apertures, with serrated edges. There are two small openings in the "handle." The anchors, about the same length as the plates, are articulated to the end of the last-mentioned process, and present slight serrations on the flukes.

List of Echinodermata.

Ophiura albida.
Ophiocoma brachiata.
filiformis.
bellis.
granulata
rosula.
Astrophyton Elizabethæ, *n. s.*
Uraster glacialis.
Uraster rubens.
Cribella oculata.
Solaster papposa.
Echinus sphæra.
Ocnus brunneus.
Synapta Galliennii.
Buskii, *n. s.*

Gephyrea.—*Priapulus caudatus* was met with in great abundance in the sandy mud of a creek at low water; some of the specimens, independently of the long tail, measuring 6 inches in length. A great change will require to be made in the descriptions of Professor E. Forbes, for he does not notice the presence of the horny teeth of the proboscis, with their curved central and three lateral fangs, or the occurrence of papillæ in rows on the same organ, or on the body and processes of the tail.

Besides the common *Sipunculus Bernhardus* and *S. Johnstoni*, a new Syrinx (Forbes), Dendrostomum (Quatrefages), was found. *Dendrostomum Huxleyii*,* new sp.; from under a stone lying on muddy sand. It stretched itself when living to the length of 7 inches, both extremities being tapered. Body of a uniform dull brownish hue, elongated, vermiform, and with the proboscis abruptly separated anteriorly by a well-marked shoulder; instead of having a smooth body, as in *S. Harveii* (Forbes), to which it seems most nearly allied, this is everywhere marked by fine transverse lines, closely studded with small papillæ, just visible to the naked eye. The shoulder and base of the proboscis present the most conspicuous carunculæ, those at the tapering, downy, posterior extremity being somewhat less marked, from the absence of rugæ. The proboscis is about an inch and a quarter in length, very rugose at the base, more finely papillated towards the extremity, near which the papillæ sharp like spikes, and towards the buccal cirri marked as minute black dots.

List of Gephyrea.

Priapulus caudatus.	Sipunculus Bernhardus.
Dendrostomum Huxleyii.	Johnstoni.

Fishes.—The most conspicuous character in the class of fishes (of which thirty-three species were observed) was the abundance of the *Wrasses* that swam in shoals at the margin of the rocks, or lurked under the sea-weeds of rock pools. Numerous examples of *Lepidogaster bimaculatus* and *Siphonostomus Typhle* were caught in the laminarian region around the little islands.

* Named after Professor Huxley, London.

Salmon and trout were everywhere plentiful. Attached by a long, slender, central appendage (like that of a *Chalimus*) to the pectoral region of a *Motella glauca*, that swam amongst the salpæ, was a remarkable crustacean parasite (fig. 7). A malformed young *Turbot** was also caught as it disported itself amongst the salpæ, having both *sides* of its body coloured, and with an eye on each; opercular bones on both sides armed with prickles. The dorsal fin commences rather behind the posterior border of the orbit, leaving a distinct crown of the head in front. The ventral line was flattened, had a prominent spinous process at the posterior termination of the lower jaw, in a line with the posterior part of the orbit, and a deep notch behind the rudimentary ventral fins. The directions of the axes of the eyes were different. The anal fin commenced behind the ventral notch. There was little abnormality in either pectoral or caudal fin, save that the latter was directed somewhat downwards (ventrally).

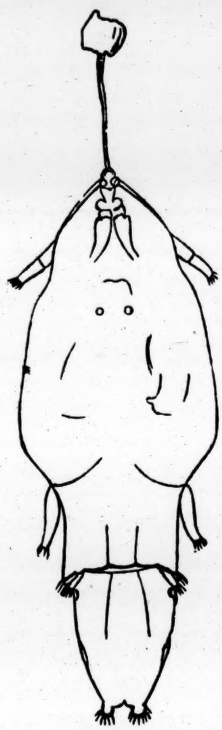


Fig. 7.

List of Fishes.

Anguilla latirostris.
Conger vulgaris.
Ammodytes lancea.
Clupea harengus.
Salmo salar.
Fario argenteus.
Labrus maculatus.
Ctenolabrus rupestris.
Crenilabrus pusillus.
Gadus morrhua.
    œglefinus.
Merlangus carbonarius.
Lota molva.
Motella quinquecirrata.
    glauca.
Psetta maxima.
    rhombus.
Platessa flesus.
    limanda.
Acanthocottus scorpius.
Gasterosteus trachurus.
    spinachia.
Gobius bipunctatus.
    minutus.
Lepidogaster bimaculatus.
Cyclopterus lumpus, young.
Liparis vulgaris.
Blennius pholis.
Muræenoides guttata.
Lophius piscatorius.
Siphonostomus Typhle.
Acanthias vulgaris.
Raia batis.

* In my diagnosis of this animal I was aided by Dr R. H. Traquair, who has recently published many valuable observations on the Pleuronectidæ, *Linn. Trans.*

2. On the Natural History of Lewis. By Professor Duns, D.D., F.R.S.E.

Comparatively little attention has been given to the natural history of Lewis. Stray notices of the geology, botany, and zoology of the Outer Hebrides are to be met with, but, with one or two exceptions, these are not of much value. Martin's "Description of the Western Islands (1703)," is chiefly interesting for its full account of the industrial and moral condition of the people. Little, however, can be made of his incidental references to the natural history of the islands. Two volumes on the "Economical History of the Hebrides," by Rev. Dr Walker, Professor of Natural History in the University of Edinburgh, were published in 1808, after Dr Walker's death. This work contains a good deal of information on indigenous plants, but almost none on zoology. Dr Maculloch's "Description of the Western Islands of Scotland (3 vols., 1819)," is in every way an abler and better work than either of the two now named. Its notices of the geology and mineralogy of the Outer Hebrides are even still valuable. The only other work calling for notice here is the late Mr James Wilson's "Voyage Round the Coast of Scotland and the Isles (2 vols. 1842)." Mr Wilson spent a short time at Stornoway, but the work contains only one brief reference to the zoology of the district. He names starlings, redbreasts, larks, thrushes, and sand-martens as the only land birds seen by him near that town.

In addition to these works there are several separate papers on the natural history of the Long Island, which should be named. Two were published by the late Professor Macgillivray, in the second volume of the "Edinburgh Journal of Natural and Geographical Science (1819)," and another by Mr John Macgillivray, on the "Zoology of the Hebrides," in the "Annals of Natural History (vol. viii. 1840)." These papers are chiefly devoted to the zoology of Harris, and are very imperfect. In the "Transactions of the Botanical Society of Edinburgh (1841)," Dr Balfour published a very complete list of the plants of the "Outer Hebrides and Skye." Captain Thomas's interesting paper on "The Geologic Age of the Pagan Monuments of the Outer Hebrides (*Proc. Royal Phys. Soc.* 1862)," contains valuable particulars as to the supposed

rate of growth of peat, changes in the surface deposits of the localities referred to, &c.

I visited Lewis last summer, chiefly with the view of looking at its zoology and surface geology. In the present paper, attention is limited to the mammals, birds, reptiles, and land mollusca.

MAMMALIA.

VESPERTILIONIDÆ,	Common Bat,	*Vespertilio pipistrellus.*
MUSTELIDÆ,	Otter,	*Lutra vulgaris.*
	Common Martin,	*Martes foina.*
PHOCIDÆ.	Common Seal,	*Phoca vitulina.*
	Grey Seal,	*Halichœrus gryphus.*
MURIDÆ,	Common Mouse,	*Mus musculus.*
	Norway Rat,	*Mus decumanus.*
LEPORIDÆ,	Common Hare,	*Lepus timidus.*
	Alpine Hare,	*Lepus variabilis.*
CERVIDÆ,	Red Deer,	*Cervus elaphus.*
DELPHINIDÆ,	Common Porpoise,	*Delphina phocœna.*
	Grampus,	*D. orca.*
	Round-headed Porpoise,	*Phocœna Melas.*

AVES.

FALCONIDÆ,	Ring-legged Buzzard,	*Buteo lagopus.*
	Common Buzzard,	*B. vulgaris.*
	Golden Eagle,	*Aquila chrysaëtus.*
	White-tailed Sea Eagle,	*Haliaëtus albicilla.*
	Fishing Osprey or Fish Hawk,	*Pandion haliaëtus.*
	Iceland or Jer-Falcon,	*Falco gyrfalco.*
	Peregrine Falcon,	*F. peregrinus.*
	Merlin,	*F. œsalon.*
	Kestrel,	*F. tennunculus.*
	Sparrow Hawk,	*Accipiter nisus.*
STRIGIDÆ,	Snowy Owl,	*Syrnea nyctea.*
	Common Owl,	*Strix aluco.*
	Barn Owl,	*S. flammea.*
	Bare-Toed Day Owl (?),	*Noctua nudipes,* Gould, (?).
HIRUNDINIDÆ,	Chimney Swallow,	*Hirundo rustica.*
	Sand Martin,	*H. reparia.*
CAPRIMULGIDÆ,	Goatsucker,	*Caprimulgus Europœus.*

CUCULIDÆ,	Cuckoo,	*Cuculus canorus.*
CORVIDÆ,	Raven,	*Corvus corax.*
	Hooded or Grey-backed Crow,	*C. cornix.*
	Rook,	*C. frugilegus.*
STURNIDÆ,	Starling,	*Sturnus vulgaris.*
TURDIDÆ,	Dipper,	*Cinclus Europæus.*
	Blackbird,	*Turdus merula.*
	Ring Ousel,	*T. torquatus.*
	Fieldfare,	*T. pilaris.*
	Song Thrush,	*T. musicus.*
	Redwing,	*T. iliacus.*
	(*Sylvinæ*).	
SYLVIIDÆ,	Garden Warbler,	*Sylvia hortensis.*
	Willow Woodwren,	*S. trochilus.*
	Gold Crest,	*Regulus auricapillus.*
	Common Wren,	*Troglodytes vulgaris.*
	(*Erythacinæ*).	
	Redbreast,	*Erythacus rubecula.*
	White-rumped Stone Chat,	*Saxicola œnanthe.*
	Whin Chat,	*Fruticicola rubetra.*
	(*Parinæ*).	
	Blue Tit,	*Parus cæruleus.*
	(*Motacillinæ*).	
	Pied Wagtail,	*Motacilla Yarrelli.*
	(*Fringillinæ*).	
FRINGILLIDÆ,	Chaffinch,	*Fringilla cœlebs.*
	Mountain Finch,	*F. montifringilla.*
	Grey Linnet,	*F. cannabina.*
	Twite,	*F. montium.*
	Greenfinch,	*F. chloris.*
	House Sparrow,	*Passer domesticus.*
	(*Emberizinæ*).	
	Common Bunting,	*Emberiza miliaria.*
	Yellow Hammer,	*E. citrinella.*
	Reed Sparrow,	*E. schœniclus.*
	Snowflake,	*Plectrophanes nivalis.*
	(*Alaudinæ*).	
	Meadow Pipit,	*Anthus pratensis.*
	Shore Pipit,	*A. obscurus.*
	Sky Lark,	*Alauda arvensis.*

COLUMBIDÆ, .	Wood Pigeon, . . .	*Columba palumbus.*
	Rock Dove, ...	*C. livia.*
	Turtle Dove (?), . . .	*C. turtur.*
PHASIANIDÆ, .	Common Pheasant, . .	*Phasianus Colchicus.*
PERDICIDÆ, .	Common Partridge, . .	*Perdix cinerea.*
TETRAONIDÆ, .	Black Grouse, . . .	*Tetrao tetrix.*
	Red Grouse, . . .	*T. Scoticus.*
	Ptarmigan, ...	*Lagopus cinereus.*
GRUIDÆ, . .	Grey Crane, . . .	*Grus cinerea.*
PLURIOLIDÆ, .	Golden Plover, . . .	*Charadrius pluvialis.*
	Dotterel, ...	*Pluvialis morinellus.*
	Ring Plover, . . .	*Charadrius hiaticula.*
	Lapwing, ...	*Vanellus crestatus.*
	Turnstone, ...	*Strepsilas interpres.*
	Oyster Catcher, . . .	*Hæmatopus ostralegus.*
	Grey Sandpiper, . . .	*Tringa canutus.*
	Purple Sandpiper, . .	*T. maritima.*
	Dunlin, ...	*T. cinclus.*
	Sanderling, ...	*Calidris arenarea.*
	Curlew, ...	*Numenius arqueta.*
	Whimbrel, ...	*N. phæopus.*
TOTANIDÆ, .	Redshank, ...	*Totanus calidris.*
SCOLOPACIDÆ, .	Common Snipe, . . .	*Scolopax gallinago.*
	Jack Snipe, ...	*S. gallinula.*
	Woodcock, ...	*S. rusticola.*
ARDEIDÆ, . .	Common Heron, . . .	*Ardea cinerea.*
RALLIDÆ, . .	Water Rail, ...	*Rallus aquaticus.*
	Land Rail, ...	*Crex pratensis.*
	Water Hen, ...	*Gallinula chloropus.*
	Coot, ...	*Fulica atra.*
ANATIDÆ, . .	Grey Lag Goose, . . .	*Anser ferus.*
	Wild Goose, . . .	*Anas anser.*
	Short-billed Goose, . .	*Anser brachyrhyncus.*
	White-fronted Goose, . .	*A. albifrons.*
	White-faced Bernicle Goose,	*Bernicla leucopsis.*
	Swan, ...	*Cygnus musicus.*
	Shieldrake, ...	*Anas tadorna.*
	Mallard, ...	*A. boschas.*
	Teal, ...	*A. crecca.*
	Pintail Teal, . . .	*A. acuta.*

ANATIDÆ,	Wigeon,	*A. Penelope.*
	Broad-billed Scaup Duck,	*A. marila.*
	Tufted Pochard,	*A. fuligula.*
	Velvet Scoter,	*A. fusca.*
	Black Scoter,	*A. nigra.*
	Eider Duck,	*A. mollisima.*
	Golden Eye,	*A. clangula.*
	Gooseander,	*Mergus merganser.*
	Red-breasted Gooseander,	*M. serrator.*
COLYMBIDÆ,	Little Grebe,	*Podiceps minor.*
	Great Northern Diver,	*Colymbus glacialis.*
COLYMBIDÆ,	Black-throated Diver,	*C. arcticus.*
	Red-throated Diver,	*C. septentrionalis.*
ALCIDÆ,	Common Guillemot,	*Uria troile.*
	Black Guillemot,	*U. grylle.*
	Little Auk,	*Alca alle.*
	Razor Bill,	*A. torda.*
	Puffin,	*A. arctica.*
PELICANIDÆ,	Cormorant,	*Pelecanus carbo.*
	Shag,	*P. graculus.*
	Gannet,	*P. bossanus.*
PROCELLARIDÆ,	Fulmar,	*Procellaria glacialis.*
	Manx Shearwater,	*Puffinus Anglorum.*
	Stormy Petrel,	*Procellaria pelagica.*
LARIDÆ,	Richardson's Skua,	*Lestris Richardsonii.*
	Kittiwake,	*Larus rissa.*
	Great Black-backed Gull,	*L. marinus.*
	Lesser Black-backed Gull,	*L. fuscus.*
	Herring Gull,	*L. argentatus.*
	Common Gull,	*L. canus.*
	Brown-hooded Mew,	*L. ridibundus.*
	Common Tern,	*Sterna hirundo.*
	Arctic Tern,	*S. arctica.*

REPTILIA.

Stone Worm,	*Anguis fragilis.*
Common Adder,	*Vipera berus* (?)

MOLLUSCA (LAND).

Limax agrestis, Zonites cellareus, Z. nitidus, Helex aspera, H. nemoralis, H. rotundata, Zua lubrica.

These lists are not a little suggestive, when regarded from the point of view of the geographical distribution of animals. Taking into account the climatal condition of Lewis, its relation to the mainland and to the islands of the Outer Hebrides group, it will be seen that its fauna contains forms which could scarcely have been looked for there, and that others are absent which we might have expected to find. Its climate is comparatively mild, and not so humid as many believe. The mean annual temperature is 46°·5′, and the average annual rain-fall is not more than 30·2 inches. The greatest cold is seldom more than 35°, and the greatest heat 65°.

In the list of mammalia the *Mustelidæ* are represented by two genera, *Lutra* and *Martes*. It is, however, remarkable that neither the common weasel, the stoat, nor the polecat, should be met with in a locality which still shelters one of the least common Scottish forms of this family—the rapidly decreasing *Martes foina*. This animal, whose skin still sells at a price varying from 14s. to 20s., occurs in Sir James Matheson's deer forest, Mhorsgail. Under the family *Phocidæ*, the common seal and the grey seal are named as known to breed on the west coast of Lewis. When Martin visited the district more than 160 years ago, he wrote—" Seals are eaten by the vulgar, who find them to be as nourishing as beef and mutton." Two species of *Muridæ* occur—the common mouse and the Norway rat. In almost all other districts these species are found associated with the shrews, the voles, and the field mouse, none of which are met with in Lewis. It is curious, too, that while the common and Alpine hares abound, there are no rabbits. Several attempts to introduce them have failed. The fox, hedgehog, mole, and badger, are also absent, yet these, I believe, all occur in Skye. The number of species of Mammalia which fall to be associated with Lewis is thirteen. In the same way, the number of species of birds is 110. Many of these, however, are occasional visitors. The number of reptiles is one, and of land mollusca seven. A careful examination may add some forms to the last; but I do not anticipate that the list of birds will have many names added.

Many of the birds came under my own observation. Others are named from a collection preserved at the gamekeeper's lodge, near

Stornoway Castle. Several of the rarest forms are among these. For the names of others I am indebted to Mr Liddle, farmer, Gress, an intelligent and trustworthy observer.

Not fewer than ten species of *Falconidæ* occur in Lewis, or in some of the islands on the east and west coast. The golden eagle is seen throughout the year; in winter singly, in summer often in pairs. The belief is common among the people that this species takes salmon, as well as hares, moorfowl, &c. The white-tailed eagle, in its turn, poaches on the territory of the golden one. It has been often known to take lambs as well as salmon, and is said to have killed a fawn in Mhorsgail Deer Forest. The fishing osprey is more common than either of these. It nests in the Shiant Islands, and may not unfrequently be seen on the Uig coast. The jer-falcon is only an occasional visitor. It is more frequently seen in the Flannen Isles, on the west coast of Lewis. The peregrine falcon is observed throughout the year. It is noted as a bold hunter, and very destructive to young grouse. When pressed by hunger it will attack the old also. Its favourite prey is the rock pigeons, which abound on the west coast especially. The merlin was once abundant, but is now comparatively rare. The sparrow-hawk is common. The kestrel is not so. Two snowy owls were shot at the Butt in 1855, and one at Uig in 1859. The common and barn owls are comparatively rare. A good observer described to the author a species which he had once seen, as small, bare on the toes, brown above and yellowish below. The description suggested *Noctua nudipes* of Gould; but this is of very rare occurrence in Britain, and even on the Continent it is seldom met with north of lat. 55°.

The cuckoo frequently appears in the end of April, but its usual time seems to be from the 10th to the 15th of May. Writing of Rona, Martin makes the following note:—"The inhabitants of this little island say that the cuckow is never seen or heard here, but after the death of the Earl of Seaforth or the minister!"

Among the *Corvidæ*, the raven and grey-backed crow are common. Both of these birds are very bold, and destructive to grouse. The former not unfrequently attacks diseased sheep, and picks their eyes out before the animals are dead. Several of the latter have been seen to attack the female grouse, when covering

her young, drive her away, and fly off with a young bird each. Both build in the wild cliffs overhanging the sea, but they are often met with in the moors. The rook is rarely seen in Lewis. It is noticed only as an occasional visitor in winter, and, when disturbed, takes flight in the direction of the mainland; yet there is abundance of food for it. Not only does the earthworm abound, but many hurtful grubs also. Cultivated patches were pointed out to me as having been destroyed by mildew, but on pulling up the plants by the roots, numerous wire worms of *Tipula* and *Elator* were seen.

The jackdaw is absent, but the starling, which in many of its habits resembles this bird, is very abundant. The starling builds in the holes of rocks, and seems to be much more particular about its nest than it is in the south. In Lewis it uses moss and wool as a lining, and is often seen on the sheep's back, not feeding on the ticks, which it sometimes does, but quietly pulling out the wool for nest-lining.

Six species of the family *Turdidæ* occur. Of these the dipper is the least common. The ring ousel is met with in summer. An interesting illustration of what might be called the adaptive power of instinct came under my notice in the little island named Pabba, near the Uig shore. On the 15th of June 1865, when examining the rocks of the island, I met with a nest of the common thrush, containing four eggs. In placing it at the top of a sand-covered rock, over the edge of which long stalks of lyme grass drooped, the bird had availed itself of these for a kind of cradle for the nest. Indeed, some of the leaves were woven into the outer covering of the nest, which was thus hung out over the bank. In the Low-lands the favourite nesting-place of the thrush is a tree or a bush; but as these are of rare occurrence indeed in Lewis, the bird yields to circumstances, and places its nest in the hollows of the rocks, or on the top of sand-banks near the shore. In this case it had managed to place it where it would swing in the breeze. The nesting-time of the thrush in the south is in April and the beginning of May. These birds occur in great numbers all over Lewis. The missel-thrush and redwing appear in winter. In the south the former is most common, in the north the latter.

The family *Sylviidæ* is well represented. Some members occur

in Lewis, which we could not have expected to find. I met with the garden-warbler, the willow wood-wren, and the pretty little gold-crest, in the plantation around Stornoway Castle. The age of the trees and bushes there is not great. These birds must thus have found their way thither after the plantation was made. It would be interesting enough if we could trace the path of their progress north, especially as they arrive only a few days later than those which frequent the neighbourhood of Edinburgh. The presence of the blue tit is as curious. Of related forms the pied wagtail and yellowhammer, whinchat and redbreast, may be mentioned as not common.

The lark may be named the bird of Lewis. On every moor, in every cultivated spot, inland or along the shore, wherever there is a bit of turf, you meet this bird. Some have thought that the increase of starlings in the Lowlands has thinned the number of larks. In Lewis both are very abundant.

Among the *Fringillidæ*, perhaps the least common is the house-sparrow. "A pair of sparrows," says James Wilson, in the work referred to above, "built in Stornoway in 1833, but we did not see their descendants in 1841." I believe that the date of the introduction of the sparrow into Lewis is correct. They are now spread all over the country; but in few localities, except in Stornoway, do they breed in the eaves and thatch of houses. Even the sparrow turns away from the wretched huts in which the majority of the people dwell. Here, again, we have an illustration of the influence of habit on instinct. Were a sparrow to build a nest in the thatch of one of these wretched hovels, it would be almost sure to be destroyed when the eggs were dropped. To prevent the escape of smoke almost all the huts are built without a chimney. Windows occur in very few of them, and the doors are smaller than those of cottages in the Lowlands. The object of this is to direct the peat smoke into the loose thatch, in which the soot may lodge. In spring this part of the covering is taken off, and spread over the "lazy beds," in which barley and green crops are to be raised. Thus manured, they yield abundant crops. The sparrow has been taught the uncertainty of tenure in such roofs, and builds its nest in the holes of rocks instead of the habitations of man.

The *Columbidæ* are represented by the rock-pigeon and the wood-

pigeon. The former is very abundant; the latter is only seen occasionally in spring or in autumn. Some years ago one of Sir James Matheson's keepers shot a specimen of the turtle dove. This, I believe, is the only instance in which this bird has been met with so far north.

When the pheasant was first introduced, it roosted habitually on the trees near Stornoway Castle. This it seldom does now. Has it, too, learned something by experience? It has nothing to dread from fox, or polecat, or ermine; and the marten, which would be destructive to it, frequents a distant locality. Efforts have been made to introduce the black grouse, but they have not as yet been successful. Walker seems to have met with it on the occasion of his visit to these islands. He says, "The stomach of the black-cock is often found stuffed in spring with the *Polypodium vulgare*;" and adds, "This is the only certain instance that has occurred of any animal living upon a plant of the fern kind in this country." Ptarmigan are very common, especially on the Lewis slopes of the Harris hills. The red grouse is not fit for shooting till about September.

One species of *Gruidæ*, the grey crane, has several times been shot in severe winter weather. Of the *Pluvialidæ*, the golden plover is very abundant in the moors during summer. In winter it retires to the shore. The dotterel is seen in June and July, and the ring-plover is very abundant throughout the year. Mr Macgillivray says that the lapwing is of extremely rare occurrence in the Hebrides. This is a mistake; I saw it frequently. Its habits as to change of place are similar to those of the golden plover. The turnstone is met with during winter. The oyster-catcher is abundant. I found several nests on a shelving rock near Gallan Head, with eggs in them, on the 14th of June. In some the shell was beginning to break, and the "peep-peep" of the chick could be heard. In the Fern Islands the young of this bird appear a fortnight earlier. The nesting-place was a hollow in the large rock, without lining of any kind.

Of the *Tringidæ*, the grey sandpiper arrives in small flocks in September, the purple sandpiper appears for a few weeks in spring, the dunlin is abundant on the Uig coast in June, the sanderling arrives early in September, and departs in March, the curlew is

abundant, and the whimbrel is seen in May for a short time. It does not seem to breed in Lewis.

The *Totanidæ* are represented by the redshank, which is not common, and is seen only in summer. Three species of *Scolopacidæ* are met with. The common snipe is abundant throughout the year. The jack-snipe is not common in winter. The woodcock arrives, but not in great numbers, in October. In no case have they been known to remain during summer.

The common heron is often observed in winter; very seldom at any other season. The water-rail is not common. It is found throughout the year. The land-rail arrives between the middle and end of May; but a curious fact was brought under my notice in regard to it: its cry is frequently heard in Bernera, Uig, ten days or a week earlier than in the Long Island itself.

No fewer than nineteen species of *Anatidæ* have been met with in Lewis. Among these, the grey lag and bean goose are seen occasionally in winter; the pink-footed or short-billed goose breeds in the Flannen Islands; the white-fronted goose, the swan, shieldrake, velvet and black scoters, appear in winter; the pintail teal is rare. The wigeon has frequently been shot in Lewis, though Mr Macgillivray says, "In the north of Scotland they are uncommon; on its north-west coast scarcely ever seen; in the Outer Hebrides, I believe, never." The broad-billed scaup duck is a rare winter visitant. The eider duck breeds in the Flannen Isles. I saw a pair which had been brought to Bernera two days before my visit. I observed a pair of the golden eye on a small lake in Uig in June. I watched them with a field-glass for about an hour. One of Sir James Matheson's keepers was with me, but they never came within gun-shot. The gooseander breeds occasionally in the district.

All the other forms named in the list of birds are abundant, with the exception of the little grebe, which is not very common.

Under *Reptilia* I have set down the common adder; but its occurrence in Lewis is apocryphal, though assured by several that they had seen what must have been an adder. The only reptile is the slow worm, of which the people have a great and superstitious dread, though it is perfectly harmless. The frog, the toad, and the newt are absent. On this account, the people call Lewis a blessed country, in being so free from the evil creatures that abound in the south!

3. On M. Mége Mouriés' Process of Preparing Wheat Flour. By Professor Wilson.

Some twelve years ago M. Mége Mouriés had his attention directed to the composition of the grain of wheat, and to the processes of grinding and panification. The object of that gentleman's investigations was to show the defective knowledge and waste of material in the ordinary practices of the trade; but although these were fully proved by the results, there appeared to have been trade and other difficulties in the way of its general adoption. Having last year acted as juror on "Food Substances" at the Dublin Exhibition, I had my attention recalled to the subject by an article which was submitted to the jury under the name of "Cerealina," purporting to be a preparation of wheat flour by the process indicated by M. Mége Mouriés, and which, on examination, confirmed the opinions which had been previously formed of its food value. On further inquiry, it was found that a simple mechanical process had been devised in the United States, where the flour had been prepared, for effecting the most difficult part of M. Mége Mouriés' process—that of decorticating the grain. This rendered the operation of preparation so easy and so inexpensive as to make it desirable that attention should again be called to the process. In examining the composition of the grain of wheat, M. Mége Mouriés found that it was a far more complicated structure than was commonly supposed—that it consisted of (1) an outer covering or epidermis, (2) epicarp, (3) endocarp, and that these three layers consisted chiefly of ligneous tissue, and formed the exterior covering of the grain or true bran, and had no food value. Together, they averaged from two to three per cent. of the weight of the wheat. Beneath these came (4) the testa or seed-coat proper, which was a distinct cellular tissue of a dark colour—yellow or orange, according to the description of the grain; and (5), the embryo membrane, directly connected with the germ, which, indeed, it supplied as soon as the vital principles of growth were excited. These two coats or layers contained nitrogenous matters in large proportions, and enveloped the mass of starch-cells which formed the body of the grain. Ordinary flour was composed entirely of

these interior starch-cells—the remaining portions of the grain being separated in the shape of bran, and carrying away with them, at the same time, a proportion, generally five or six per cent., of the flour also. M. Mége Mouriés found that the gluten contained in the grain was very unequally divided; that while in the epidermis or the true bran it was least, it existed in larger quantity in the two next layers than it did in the starch-cells or flour of the interior. He therefore recommended that the grain should be merely decorticated previous to grinding, and that the layers of cells, so rich in gluten as the testa and embryo membrane, should be ground up with the starch cells, and form part of the flour used for bread or other food purposes. From an analysis which has been made by Dr Lyon Playfair, I found that by this process the true bran contains only 4·571 per cent. of gluten instead of 15·019 by the ordinary process. The flour made by M. Mége Mouriés' process contains 15·672 per cent. of gluten, as compared with 9·795 in the ordinary flour. By merely taking off the outer covering of the grain, which is perfectly valueless as an article of food, instead of following the ordinary process, which takes off at least 14 per cent. of bran, fully 10 per cent. is added to the food portion of wheat, while the nutritive value of flour is increased by about 60 per cent. This, upon the wheat consumption of the kingdom,—say 20,000,000 of quarters,—is a matter of considerable importance. Another important advantage is secured by M. Mége Mouriés' process in regard to the storage and preservation of wheat. It appears that the outer covering—the epidermis—absorbs moisture far more readily than the regular cellular tissue of the inner layers, and thus renders the grain more or less liable to mould and other injuries by keeping, unless great care be taken by occasionally shifting, &c. By the process of decortication this is entirely removed, and a hard, smooth surface given to the grain, from which every particle of deteriorating matter, in the shape of dirt, smut, &c., has been removed, diminishing its bulk, and leaving it ready for the miller whenever it may be required. The following is the method adopted for the preparation of the grain by M. Mége Mouriés' process:—

"Wheat is carried up to the topmost floor, then, passing through a screen or riddle, it falls through a hopper into a long narrow

trough which contains water, and is traversed through its length by an Archimedian screw. This carries the wheat slowly along the trough to the discharge end, where it now, in a moistened state, falls down a tube to the unbranning or decorticating cylinders. These are formed of cylinders of cast-iron, ridged on their interior diameters, and with closed ends. A screw shaft traverses the centre of them, carrying broad arms or floats set at an angle, diagonal, or 'aslant' to the face of the cylinder, and with a diameter so much less than that as to cause friction, but to allow the grain to pass without crushing. A rapid rotation is given to this central shaft, and, owing to the angle at which the floats are set, a slight progressive motion is given to the grain. The friction causes a large proportion of the true bran—epidermis, epicarp, &c. —to be separated; and this is removed, as it is separated, by a blast driven through the cylinder in a direction contrary to the motion of the shaft, which also has the effect of drying the excess of moisture of the grain. It then passes along a spout into a second cylinder, where it undergoes the same process; and, finally, is carried into the drying-chambers, composed of a series of iron troughs, along which the grain is propelled by screw shafts, a current of dry warm air being driven along them in an opposite direction. It then, quite dry, receives its last friction in the polishing cylinders, where the friction is limited to that of the grains themselves, and leaves it in a dry, smooth, rounded form. As this generates a considerable elevation of temperature, it requires to undergo a cooling process before storing or using. This is effected by carrying it up to the upper floor, and allowing it to fall down inclined planes through a flat shoot, up which a blast of cold air is driven."

4. Observations on Meat (Butchers'-meat), in relation to the Changes to which it is liable under different circumstances. By John Davy, M.D., F.R.SS., London and Edinburgh, &c.

Animal food is of so much importance, in relation to our wants as to diet, that I have been induced to make some experiments on

it, with the hope of obtaining useful results. These I now submit to the Society, imperfect as they are, trusting that they may not prove altogether useless, and that they may lead to further inquiry.

1. *Of Degree of Temperature as modifying Change.*

It is well known how rapidly meat undergoes the putrefactive change in the height of summer, and in tropical climates at all seasons; and, on the contrary, how long it may be kept free from putridity during our winter, and more especially at the freezing temperature, and degrees of temperature approaching the freezing,—in this, as in the preceding instance, fully exposed to the air of ordinary atmospheric humidity.

In the comparative trials I have made in each season, for the sake of precision, the meat used has been divided into two portions,—one, suspended by a thread, has been fully exposed to the air of the room; the other has been suspended in a receiver over a little water,—the receiver, so covered as to admit air, and yet prevent rapid desiccation by evaporation.

In one experiment on portions of lamb, made at a temperature varying from 60° to 65° of Fahr., between the 11th and 12th of August, the results were strikingly different. The portion fully exposed to the air lost weight rapidly, and soon became dry and hard, without acquiring any putrid taint; whilst the other, on the contrary, softened, and for most part actually liquified, at the same time becoming extremely putrid.* I have mentioned these results in a note, in a paper published in the last volume of the Society's Transactions,† and in the same note have adverted to the fact of the perfect preservation of the meat during the like time and temperature over water in vacuo.

In a second trial made in winter, a portion weighing 141·1 grs., exposed freely to the air, became dry and hard in twenty-three days, viz., from the 27th of October to the 19th of November, the thermometer in the room averaging about 55°. During this time

* The droppings from the putrifying meat have had some resemblance to chyme, being found to consist of a fluid coagulable by heat, in which were suspended, as seen with a high magnifying power, innumerable granules, some fibres, and some minute crystals.

† Transactions, vol. xxiv. p. 137.

it lost by evaporation 95·6 grs., or 67·7 per cent.; and it lost no more from further exposure.

Another portion of the same meat, weighing 74·5 grs., suspended over water lightly covered, retained during the same time much of its humidity, and shortly became covered with a delicate, white filamentous growth of the mucednous kind, not unlike very fine hair.* It emitted the peculiar smell of mould, and the water beneath had a taint of the same. On the 15th of December it was reduced to 26·6 grs., or had lost 65·2 per cent. The delicate white fibres were somewhat shrunken; the upper moiety had become darker; cut into, the mouldiness was found to be superficial; the interior, of a darkened colour, was of increased translucency; its muscular fasiculi were distinct; their structure so little altered, that when moistened with dilute acetic acid their striæ were seen well defined. Underneath, in the water, there was a little white sediment, which was found to consist chiefly of cells (spores) thrown off from the mildewed surface. Evaporated to dryness, the residue weighed only ·4 gr. Replaced over fresh water, this water, in three days, had become slightly turbid from spores suspended in it, and had acquired the peculiar smell of mould.† The portion of meat was now freely exposed to the air; it soon shrunk and became hard; and when it sustained no further loss from evaporation it was reduced to 21 grs., a loss of 71·6 per cent.—a part of which loss, it may be presumed, was owing to the vegetable growth.

In the paper already referred to, I have mentioned that dried meat does not attract the flesh-fly, only the putrid in progress of deliquescence, when it affords a fit nidus for the larvæ of this fly, and for their nutriment. I may further remark that the temperature at which the flesh-fly loses its activity, and is no longer seen

* This may help to account for what is stated of a body long buried, which, after forty-three years, was found as reported almost entirely covered with hair. According to the narrative: "The cover of the coffin having been removed, the whole corpse appeared perfectly resembling the human shape, exhibiting the eyes, nose, mouth, ears, and all the other parts, but from the very crown of the head to the sole of the feet covered over with hair, long and much curled." A specimen of this hair-like substance was considered worthy of a place in the repository of Gresham College. (See *Phil. Trans.* abridged, vol. ii. p. 490.)

† Spores were found also on the inner surface of the glass covers. When thrown off, it may be inferred that they are readily diffused in currents of air.

(one of about 50°), is also that at which the deliquescent process of putrefaction ceases and the mould-growth takes its place.

2. *Of a Moist or Vaporous state of Atmosphere as modifying Change.*

The influence of warmth and moisture of atmosphere in promoting the putrid decomposition of animal matter is an established fact. It is well known that within the tropics, especially in littoral regions where the thermometer ranges between 78° and 83° or 84°, and the atmosphere is commonly damp, the difference between the moistened and dry bulb seldom exceeding 5° or 6°, putrefaction is so rapid that meat cannot be kept more than a few hours without acquiring a putrid taint. When, however, the air is very dry, as in Nubia and the African deserts, then the putrefactive process is very much arrested, though the temperature may be high. At Malta a wind occasionally prevails,—a south-west wind, coming from Africa,—which, in the summer season, I have known as high as 105°, and so dry that the difference between the moistened and dry-bulb thermometer has been as much as 30°. The atmosphere of Nubia is somewhat of the same character; and its quality, as to the checking of the putrefactive change, is well shown by a passage in a very charming book by a lady,—Lady Duff Gordon's "Letters from Egypt," 1863–65; writing from that country, Nubia, she remarks: "Fancy that meat kept ten and fourteen days under a sun which I was forced to cover my head before! In Cairo you must cook your meat in two days; in Alexandria as soon as killed, and the sun is nothing there. But in Nubia I walked till I wore out my shoes and roasted my feet: and I was as dry as a chip in Nubia and as low down as Kiné, below Thebes some way; after, it altered, and, though cold, I perspired again." I may mention another striking example. In the early spring of 1826 I visited the Greek island of Ipsara, a little more than two years after it had been invaded and devastated by a merciless Turkish force.* We found it a desert, the town in ruins, only one of the inhabitants remaining, who served as our guide, all the rest, excepting those who escaped in their ships, or were captured and enslaved, having been massacred. On one side of the island, exposed to the south-east wind, the moist sirocco,

* This was in June 1824, about midsummer.

on a spot where the carnage had been greatest, only bleached bones were to be seen; whilst on the other and opposite side, exposed to the north, to the dry Etesian wind, at a battery called Fetellio, which had been heroically defended, we found two or three hundred bodies still remaining, lying as they fell, and so little were they changed that our companion was able, though their faces were blackened and shrunk, to recognise each individual by his features. They had become, as it were, natural mummies; their clothes—for they were all clad—had apparently suffered little decay; and their hair, except that it was a little bleached, showed its natural colour.

Whether such a checking of putrefaction is owing to a rapid desiccation of the surface and a retardation of the entrance and penetration of oxygen, or to other less obvious causes, may be a question. I am disposed to consider it owing to the former, inasmuch as putrefaction always begins at the surface,* and from the circumstance that desiccating substances, such as quicklime, prevent putrefaction.†

3. *Of Cooking as modifying Change.*

That the boiling or roasting of meat thoroughly enables it to be kept longer, even at a temperature and moist state of atmosphere

* It is well known to cooks, that whilst the outer surface of meat, such as venison, may be offensively tainted, the inner portion may be comparatively sweet and fit for use, especially if the deer, as soon as shot, has, according to the practice of the skilled forester, been well blooded. It need hardly be remarked, that if the blood is allowed to remain, it is itself a source of putrefaction, owing to the oxygen which it retains. The butcher, guided by experience, is most careful in expelling as much blood as possible without delay from his slaughtered animals.

† I may refer, in proof of the above, to the results of experiments given in vol. ii. of my Researches, published in 1838, confirmed by others in a later vol., that of 1863. In the former I have quoted an instance from the "Philosophical Transactions, Abridged," vol. ix., of the futility of burying the carcasses of diseased cattle with quicklime. Yet quicklime is still ordered to be used in the interment of such carcasses, but with the addition of some disinfectant. Such a procedure, no doubt, will vastly delay the decomposition of the bodies, and prevent the formation of offensive gases. Carbolic acid, one of the disinfectants recommended, has the advantage, I find, of being repulsive to dogs. A portion of meat moistened with this acid was refused by three hungry dogs.

most favourable to putrefaction, is well known to the housewife. From the few trials I have made, the process appears to arrest the putrefactive change, and to favour other changes with the production of mould or mildew.

The following is an instance:—On the 11th of July 1864, a portion of well-boiled mutton was suspended in a receiver, and covered with a plate of glass not air-tight. It weighed 82·2 grs. On the 20th of the same month it was reduced in weight to 74·3 grs., and on the 7th of August to 65·6 grs. It now had a slight smell, not agreeable, not putrid. It seemed drier, and was covered with mould of various colours, mostly white. Cut into, its interior had the smell of decaying cheese. The muscular fasciculi were distinct; and, with the aid of dilute acetic acid, their striated structure was seen. It was near, and only near, the surface, that the vegetable growth was visible. Four months later, it weighed 49·4 grs. It was drier, and had become very much darker; its colour was a very dark brown. Examined in the following December, *i.e.*, after seventeen months, some mildew was found on its surface. It had an ammoniacal and disagreeable smell, like that of rotten cheese, and it cut like such cheese. When broken, not cut, it was found friable. The muscular fasciculi still retained their form, and, with dilute acetic acid, showed the striated marking, with an increase of translucency. From another experiment of the same kind on boiled mutton, begun on the 13th of August 1864, and continued to the 11th December of the present year, like results were obtained

Blood, too, I find, after having been subjected to the boiling temperature, has its tendency to putrefy, arrested, like muscle, and that from keeping it undergoes somewhat similar changes. I may mention one instance:—On the 6th of September 1864, a portion of fowl's blood, just after it had coagulated, was boiled for several hours. The vial holding it, on its cooling, was corked, but not so tightly as to prevent the admission of air. It was placed in a room where there was no fire in winter, and, with the exception of being under cover, the temperature to which it was exposed differed but little from that of the open air. Examined on the 14th of December 1865, it was found moderately dry, for most part of a brick-red colour, partially whitish. It had an ammoniacal odour, no putrid

odour. Under the microscope, it was seen to consist chiefly of amorphous matter, of cells like the spores of mucedo, and of blood corpuscles,—these, except in form and size, but little altered;—no crystals were visible. It imparted to water only a very faint, just perceptible, brownish hue, as seen after filtration and separation of suspended particles. The water had a strong alkaline reaction, but was almost tasteless.

A clot of blood—to mention another instance—which had been boiled only ten minutes, kept the same time, offered nearly the same results. It escaped the putrefactive change; mould formed on it, which, after more than a year, was of various colours, bright red, white, and black—changes of colour, it may be conjectured, owing to the different states of the vegetation.

Is the change which meat and blood undergo after exposure to a boiling temperature, as described, in any way analogous to that which vegetables experience when converted into peat?—a conversion which appears to take place only at a comparatively low temperature—below that favouring rapid decomposition; for I am not aware of any peat-formation having ever yet been discovered in progress within the tropics or in any locality the mean annual temperature of which is above 60° of Fahr.

4. *On the Influence of Sulphurous Acid and Acetic Acid in arresting Putrefaction.*

From time to time I have made some other experiments on meats chiefly with a view to their preservation. The first instituted were with sulphurous acid, of which I have given an account in a volume of "Researches," published in 1839. The second were on vinegar, the results of which are there also described.* The sulphurous acid had previously been employed in arresting the fermentation of the more delicate white wines. I found it to arrest the putrefaction equally well of animal and vegetable substances, and so preserving them as to render them not unfit for use as human food. Trials with vinegar and dilute acetic acid gave somewhat similar results, so far as the immediate arrest of putrefaction was concerned; but it did not, like the sulphurous acid, so alter the character of the

* Researches Anatom. and Physiol. vol. i.

animal or vegetable matter as to prevent ulterior change on the removal of the acid by washing with water.*

If the subject under consideration, that of the preservation of meat, is always, from an economical point of view, deserving of attention, is it not especially so at a time such as the present, when, owing to the cattle plague, there is a danger of a stinted supply, at a greatly enhanced price?

5. The Buried Forests and Peat Mosses of Scotland. By James Geikie, Esq. Communicated by Archibald Geikie, Esq.

This communication is an attempt to eliminate the geological history of our Scottish peat mosses, which appear to contain the record of certain changes of climate, that have not hitherto fully engaged attention. The phenomena revealed by our peat mosses are threefold—First, the buried trees, and the condition of this country at the period of their growth; second, the causes which led to the destruction of these trees; and, third, the present aspect of the peat mosses. Under the first head is to be considered the continental period of Great Britain, to which the buried trees in the older peat bogs of the country belong. Under the second head, the causes of the destruction of these trees are chiefly assigned to the upward growth of wet mosses, the chilling effects of which caused the overthrow of the trees. This points to a change of climate;

* Since the experiments above referred to were made, others have been tried, the results, too, of which I may briefly describe.

On the 9th of September, a fresh parr, laid open and eviscerated, was suspended by a thread in a bottle in which was a little vinegar, the parr not in contact with the acid. Another parr, similarly prepared, was moistened with vinegar and wrapped in blotting-paper, also moistened with the acid. Thus enclosed, it was placed in an ale-glass and covered with a tumbler. After eight days the suspended parr was found well preserved; it had not the slightest unpleasant smell; its surface was not distinctly acid to the taste, and its teeth retained their sharpness. The other parr was also free from any unpleasant smell, but was softening in places; the bones were quite soft. After ten days the body of the first parr was found detached from softening, and had fallen into the acid, the head remaining suspended, and it was still free from any unpleasant smell, as was also the softened body. The parr in paper was little changed; it showed no marks of putridity.

the country was no longer characterised by an excessive or continental climate, but by an insular and more moist one. In regard to the third head—the present aspect of the peat mosses—a glance at these will convince any geologist that the peat moss formation has not only ceased to spread, but is in most cases rapidly disappearing. The moisture, which in former times afforded it nourishment and support, has now become its chief enemy. Every shower of rain, every frost, gives fresh impetus to the decay; and leaving altogether out of account the operations of agriculture, there can be no doubt that natural causes alone will in time suffice to strip the last vestige of black peat from hill and valley. The peat mosses of Scotland are only a wreck of what they have once been. The growth of the peat has ceased to be general: here and there mosses continue to increase in sufficient abundance to form that substance, but this increase is far exceeded by the general rate of decay. The peaty covering invariably shows an upper or surface stratum of heath and grasses, and is almost everywhere full of holes and winding channels. These, and other appearances, convince the writer that the climate has now become less humid—agricultural operations alone not being entirely sufficient to account for the change. The change of climate indicated by the wasted aspect of peat moss appears to have shown itself first along the southern limits of that formation in Europe. It then slowly extended its influence in a northward direction, meeting in its course with many modifications, such as must arise from local circumstances. Chief among these was the configuration of the land—the peat of low-lying districts dying out more quickly than the mosses of higher levels, where any diminution of moisture is last to be appreciated. In the same manner, the track of the rainy winds on the west and south-west coasts have also marked out a region where we now meet with less waste among the mosses than in other districts. But as the effect of such a cosmical change must be so blended with the results brought about by the progress of cultivation, the geologist can do little more than suggest the extreme probability of its existence. As it can be shown that the destruction of our ancient forests is not primarily due to man, although in the later stages of the process he certainly played an important part, so we may expect that the change from a humid to a drier climate has

also been effected by natural causes; but man, eagerly following nature, has outstripped her in her work, and so identified this with his own, that it now becomes scarcely possible to distinguish the one from the other.

The following Donations to the Library were announced:—

Transactions of the American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge. Vol. XIII. Part 2. Philadelphia, 1865. 4to.—*From the Society.*

Proceedings of the American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge. Vol. X. No. 74. 8vo.—*From the Society.*

Transactions of the Highland and Agricultural Society of Scotland. Vol. I. No. 1. 1866. 8vo.—*From the Society.*

Journal of the Royal Dublin Society. No. 34. Dublin, 1865. 8vo. —*From the Society.*

Journal of the Chemical Society. Vol. IV. Nos. 37, 38. London, 1866. 8vo.—*From the Society.*

Proceedings of the British Meteorological Society, London. Vol. III. Nos. 21, 22. 8vo.—*From the Society.*

The American Journal of Science and Arts. Vol. XLI. Nos. 120, 121. New Haven, 1866. 8vo.—*From the Editors.*

Quarterly Return (with Supplement) of the Births, Deaths, and Marriages registered in the Divisions, Counties, and Districts of Scotland. No. XLIV. 8vo.—*From the Registrar-General.*

Monthly Return of the Births, Deaths, and Marriages registered in the Eight Principal Towns of Scotland. February, 1866. 8vo. —*From the Registrar-General.*

Catalogue of the Specimens of Entozoa in the Museum of the Royal College of Surgeons of England. London, 1866. 8vo. —*From the College.*

Abhandlungen der Mathematisch-Physischen classe der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipzig. Band VII. No. 2, 3, 4, Philologisch-historischen classe. B. IV. No. 5, 6. B. V. No. 1. 8vo.—*From the Society.*

Berichte über die Verhandlungen der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipzig. Philologisch-historische

classe, 1864. No. 2, 3. Math.-Phys. cl. 1864. 8vo.—*From the Society.*

Schriften der Königlichen Physikalisch-Okonomischen Gesellschaft zu Königsberg. No. 1, 2. 1864. 4to.—*From the Society.*

Jahresbericht über die Fortschritte der Chemie und verwandter Theile, anderer Wissenschaften fur 1864. Giessen, 1865. 8vo. —*From the Editors.*

Observations Météorologiques faites à Nijne-Tagnilsk (Monts Ourals, Gouvernement de Perm) Année 1864. 8vo.—*From the Russian Government.*

Om Östersjon af S. Lovén. 8vo.—*From the Author.*

Monday, 2d *April* 1866.

SIR DAVID BREWSTER, President, in the Chair.

The President, in delivering the Neill Medal to Professor A. C. Ramsay, LL.D., F.R.S., &c., made the following remarks:—

In adjudicating the Neill Prize for the triennial period from 1862 to 1865, the Council of the Royal Society could not overlook the high claims of our eminent countryman, Mr Andrew Ramsay, Professor of Geology in the Government School of Mines, and local Director of the Geological Survey of Great Britain.

Mr Ramsay's geological studies commenced with a survey of the Island of Arran. After investigating the structure and the relations of the rocks of that interesting island, he embodied the results of his researches in a beautifully executed model, which we had the pleasure of seeing at the meeting of the British Association at Glasgow in 1840. This model, which was afterwards published on the scale of *two* inches to the mile, attracted the particular attention of Sir Henry De La Beche, the Director-General of the Geological Survey; and in the following year Mr Ramsay was appointed one of the surveyors who were then at work in the county of Pembroke.

In 1845, when the Survey was remodelled, the important office of local Director for Great Britain was conferred upon Mr Ramsay,

and he has to the present day discharged its duties with credit to himself and advantage to the Survey. He has thus not only mapped large areas with his own hand, but has had the general superintendence of the geological researches carried on under Sir Henry De La Beche, and afterwards under our distinguished countryman, Sir Roderick Murchison.

In 1847 Mr Ramsay was appointed to the Chair of Geology in the University College, London, an office which he held till 1851, when he was chosen Lecturer on Geology in the Royal School of Mines in Jermyn Street.

In the midst of these various official duties, Mr Ramsay found leisure for pursuing several interesting branches of geological research. In 1846 he published, in the *Memoirs of the Geological Survey*, a paper on the "Denudation of South Wales," which led the way to those measured details by which this branch of geology has been so greatly advanced.

In 1855 Mr Ramsay published his remarkable paper on the "Permian Breccias of Shropshire," in which he made it highly probable that there were glaciers in our latitudes during the Permian era; and he at the same time suggested, that some of the thick conglomerates of the Scottish Old Red Sandstone might, in like manner, be the representatives of an ancient glacial drift.

Mr Ramsay has distinguished himself by the energy and ability with which he has elucidated the history of the glacial period in the British islands, and by the ingenious theory in which he refers the frequent occurrence of rock-basin lakes, in the northern hemisphere, to glacier erosion during the glacial period.

No British geologist, in our day, has done more than Mr Ramsay to extend our knowledge of the causes to which the present outlines of the surface of our country is due.

In his annual addresses, as President of the Geological Society, in 1863 and 1864, he has skilfully applied his extensive and minute stratigraphical knowledge to those higher branches of philosophical geology which deal with the succession of life in time, and with the relation between the appearance of living beings on the surface of the earth and the physical changes which that surface has undergone.

For these varied and important labours, the Council of the Royal Society considered Mr Ramsay well entitled to the honour of receiving the Neill Medal. The President, addressing Mr Ramsay, then said,

Mr Ramsay, I have much pleasure in delivering to you the Neill Medal, and in congratulating you on an honour which you have so well deserved.

At the request of the Council, Professor Piazzi Smyth, Astronomer-Royal for Scotland, gave "an account of recent measures at the Great Pyramid, and the deductions flowing therefrom."

This address, which was illustrated by specimens, models, drawings, and stereoscopic photographs, referred chiefly to the four months' labour of the author in the winter and spring of 1864 and 1865 at the Great Pyramid; where he went with the approval of, and also, he thankfully acknowledges, a considerable amount of assistance from, His Highness the Viceroy of Egypt. The observations then made, comprised measures of length, angle, and heat; and are enough to fill several MS. books, which are being prepared for publication. The author, indeed, had hoped to put all these foundational facts into the hands of the public before venturing to announce any of the conclusions, but was overruled by respect for the appeal made to him by the Council of the Society on this occasion. He trusts however, still, that no one will prejudge the pyramid question on hearsay, but wait until they have all the instrumental particulars before them.

The following Gentlemen were duly elected Fellows of the Society:—

Dr John Smith.
James Falshaw, Esq., C.E.

The following Donations to the Library were announced:—

Useful Information for Engineeers. First Series. Fourth Edition. By William Fairbairn, LL.D., F.R.S., F.G.S. London, 1864. 8vo.—*From the Author.*

Useful Information for Engineers. Second Series. By William Fairbairn, LL.D., F.R.S., F.G.S. London, 1860. 8vo.—*From the Author.*

Treatise on Mills and Millwork. By William Fairbairn, C.E., LL.D. In two vols. Second Edition. London, 1864. 8vo.—*From the Author.*

Iron, its History, Properties, and Processes of Manufacture. By William Fairbairn, C.E., LL.D. Edinburgh, 1865. 8vo.—*From the Author.*

Treatise on Iron Ship-Building, its History and Progress. By William Fairbairn, C.E., LL.D. London, 1865. 8vo.—*From the Author.*

On the Application of Cast and Wrought Iron to Building Purposes. By William Fairbairn, C.E., F.R.S. Third Edition. London, 1864. 8vo.—*From the Author.*

Remarks on Canal Navigation, illustrative of the Advantage of the Use of Steam as a Moving Power on Canals; with an Appendix. By William Fairbairn, Engineer. London, 1831. 8vo.—*From the Author.*

Experiments to determine the Effect of Impact Vibratory Action and long-continued Changes of Load on Wrought-Iron Girders. By William Fairbairn, LL.D., F.R.S. 4to.—*From the Author.*

On the Law of Expansion of Superheated Steam. By William Fairbairn, LL.D., F.R.S., and Thomas Tate, Esq. 4to.—*From the Authors.*

Experimental Researches to determine the Density of Steam of different Temperatures, and to determine the Law of Expansion of Superheated Steam. By William Fairbairn, F.R.S., and Thomas Tate, Esq. 4to.—*From the Authors.*

Journal of the Royal Horticultural Society of London. Vol. I. Part 2. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society of London. Vol. I. No. 3. (New Series.) 8vo.—*From the Society.*

Journal of the Chemical Society of London. Vol. IV. No. 39. 8vo. —*From the Society.*

Quarterly Journal of the Geological Society of London. Vol. XXII. Part 1. 8vo.—*From the Society.*

List of the Geological Society of London. December 31, 1865. 8vo. —*From the Society.*

Observations on the arrested Twin Development of Jean Battista

Dos Santos. By P. D. Handyside, M.D. Edinburgh, 1866. 8vo.—*From the Author.*

Dublin International Exhibition, 1865—Kingdom of Italy—Official Catalogue, illustrated with Engravings. Published by order of the Royal Italian Commission. Second Edition. Turin, 1865. 8vo.—*From the Commission.*

Bulletin de la Société de Géographie. Tome X. Paris, 1865. 8vo. —*From the Society.*

Bulletin de la Société de Géographie. Jan. Fev. Mars 1866. 8vo.— *From the Society.*

Nova Acta Regiæ Societatis Scientatis Scientiarum Upsaliensis. Vol. V. Fasc. 2. Upsala, 1865. 4to.—*From the Society.*

Memoir of the Geographical Survey of Great Britain, and of the Museum of Practical Geology. The Geology of North Wales by A. C. Ramsay, F.R.S., Local Director of the Geological Survey of Great Britain. With an Appendix on the Fossils, with Plates, by J. W. Salter, A.L.S., F.G.S. 8vo. London, 1866.—*From Professor Ramsay, LL.D.*

Relationen einestheils zwischen Summen und Differenzen und Anderntheils zwischen integralen und differentralen. Von P. A. Hansen. 8vo. 1864.—*From the Author.*

Monday, 16*th April* 1866.

Dr CHRISTISON in the Chair.

The following Communications were read :—

1. Some Observations on Incubation. By John Davy, M.D., F.R.S., Lond. and Edin.

In this paper its author describes the results of experiments made with two intents—one, to endeavour to ascertain whether there can be a complete arrest of vital action without the death of the egg; the other to ascertain the changes which take place in those instances in which, during incubation, the egg proves unproductive.

The eggs used were chiefly those of the common fowl. The

trials to which they were subjected were of three kinds—the air-pump, the ice-house, and immersion in lime-water.

Though the results obtained were not entirely negative, yet, when reasoned on, and all the circumstances of the experiments taken into account, they have not appeared so decisive as to allow of the inference, in regard to arrested action, that that was absolute; or as regards the changes, that these, so many and different, which take place in unproductive eggs, admit of any satisfactory explanation.

2. On the Absorption of Substances from Solutions by Carbonaceous Matters, and the Growth thereby of Coal-Seams. By William Skey, Analyst to the Geological Survey of New Zealand. Communicated by James Hector, M.D., F.R.S.E., Director of the Geological Survey of New Zealand.

Some time since, during the performance of a series of analyses of the Brown Coals of Otago, my attention was directed to the very large quantity of sulphur which several of them contained, even where the most careful examination failed to detect more than traces of sulphates or sulphides in the composition of the coal, a singular fact which has been before commented upon by Dr Percy in his work on Metallurgy.

After several unsuccessful efforts to discover the form in which the excess of sulphur was present, it occured to me, that possibly the sulphur might be retained to the coal in combination with hydrogen, by a similar absorptive power to that which charcoal exercises over that gas. I therefore tried whether brown coals had the property of absorbing sulphuretted hydrogen. Finding that brown coals did possess this power, the experiments were extended over a variety of other substances in solution, and the fact was established that, with certain modifications hereafter to be described, all mineralized carbons, such as lignites, coal, and graphite, possess the power of absorbing the same substances as charcoal, especially those soluble organic matters that occur in natural waters.

The circumstance that these minerals are thus able to arrest and retain organic substances, was so suggestive in relation to the origin and physical characters of coal, that I was led to make this property of coal a special object of study, and as the course the investigation took rendered it very desirable to test the solubility of coal, this subject was also carefully examined by me, and as the results of these investigations appeared to have some degree of interest, I submitted them to the attention of Dr Hector, and with his advice and assistance, I now endeavour to state them in a concise form.

In communicating a detailed account of the various experiments employed in these investigations, the results arrived at, and the inferences they appear to justify, I have divided the whole subject into three parts, the first of which is—

I. *On Absorption as a Property of Lignite, Coal, and Graphite, in common with Charcoal.*

a. Absorption of Acids.
b. Absorption of Basic Substances.
c. Absorption of certain neutral Organic Substances.
d. Absorption of certain decomposed Organic Substances.
e. Combining quantities of bodies probably observed in their absorption.
f. Substitution effected in certain cases.

Summary.

Sufficient has been adduced by the experiments conducted by me to prove the existence of an absorptive power in lignite, coal, or graphite for many organic and inorganic substances. There is no doubt the list of such might have been almost indefinitely extended if it had been necessary; but I desired rather to establish the general fact of absorption, and to ascertain the principles which regulate it.

So far as these results enable us to judge, it would appear that generally when any substance has but a feeble solubility in water, or when it has its affinities for this liquid lowered or overpowered by other agents, such substance will be withdrawn from solution by contact with any of the foregoing bodies, lignite, coal, graphite, or charcoal. Those substances which possess basic or acid properties especially, are subject to absorption, providing such pro-

perties are not too well defined. The substances of this class can generally be abstracted from the absorbing body by the application of a suitable acid or base, as the case may be.

The fact of the absorption of acids being often facilitated by the presence of stronger acids, and that of bases by the presence of stronger bases, the application of these being indeed often absolutely necessary to produce absorption, may perhaps be accounted for by the greater affinity these stronger chemicals have for water. Thus the solvent powers of this liquid for the body we wish to determine to the coal, &c., is reduced, or altogether removed, and that state most favourable for absorption obtains. If this is so, we can perceive why sulphuric acid and the caustic alkalies are not capable of being retained by coal or charcoal; their affinity for water being so intense that it cannot be overcome by absorptive power alone, and we are not in the possession of means to remove or lower the affinity of these substances, as we have in the case of others.

But it is particularly at this stage, in the investigation of *assisted* absorption, that, as I have before observed, we are enabled to trace differences in the intensity of the absorptive power of charcoal and coal; the former body being able to absorb many acids from solution without that assistance from stronger acids required so frequently by coals, the absorbing power of the charcoal being superior to the affinity subsisting between the acid and the water, while that of coal is generally inferior. However, there is this to consider, that when we have determined the absorption of any acid to coal by the assistance of a stronger, we can remove the latter without effecting the solution of the former to any considerable extent.

General Remarks.

It is worthy of remark, as indicating a practical application of these observations, that the absorption of arsenious acid by carbonaceous substances would allow of its separation from solution for analytical purposes if desirable; arsenic acid, too, would no doubt be also absorbed, being isomorphous with one which is so, that is, phosphoric acid.

In reference to the property of phosphoric acid, of being absorbed by charcoal, &c., it is not improbable that the low decolorising

power of animal charcoal, when separated from the phosphate of lime by means of hydrochloric acid, to what it should be theoretically, may be partly due to the presence of this acid; for if animal charcoal, which has been submitted to three days' digesting in ordinary hydrochloric acid, be washed in water till nothing further is removed, and be then placed in contact with ammonia for a short time, a slight but decided crystalline precipitate, soluble in acetic acid, is obtained by adding chloride of ammonium, and sulphate of magnesia in excess of ammonia; while, if water or weak hydrochloric acid was substituted for the ammonia, and suffered to remain in contact with the charcoal for many hours, not the least indication of phosphoric acid was obtained by the application of the above test. It may be mentioned, the water employed contained a minute quantity of carbonic acid, which would probably substitute itself for a portion of the phosphoric acid absorbed to the charcoal, and thus render its detection more difficult.

The absortion of hydriodic acid by coal from acidulated solutions renders it very probable that, wherever any coal-bed is acid from the presence of the stronger acid, and has a flow of water through it, such bed will be charged with hydriodic acid in those parts which first receive the underground flow; and there, also, we may reasonably expect to find an unusual proportion of other acids, such as phosphoric, arsenic, hydrosulphuric, and hydroarsenic acids.

The property of brown coals, &c., to absorb sulphuretted hydrogen, affords a probable solution, as before shown, of the difficult problem, In what form does the sulphur exist in those highly sulphurized coals, which are comparatively free from either iron pyrites, sulphuric acid, or sulphates? That it does exist, in combination with hydrogen, to form sulphuretted hydrogen, received confirmation from further experiments, which went to prove that such coals evolved considerable quantities of this gas when subjected to temperatures ranging from 212° to 300° Fahr.

In regard to the action of decomposing organic matters upon sulphates furnishing the gas, we have only to take into consideration the general absorptive power of coal to explain the frequent association of sulphuretted hydrogen with it.

It may be stated that many of the older coals, as also samples

of graphite from England, and from the province of Nelson, New Zealand, gave indications of the presence of sulphuretted hydrogen in the vapour evolved from them by the application of a heat not exceeding 300° Fahr.

In reference to the absorption of gas, it would appear that at least carbonic acid does not owe its absorption to the porous nature of the coal alone; for substances quite as porous, such as clay, brick, blotting-paper, and wood, when dried at 212° Fahr., and placed in carbonic acid gas, did not exhibit any power of absorption. A piece of well-washed hydrate of alumina, however, was found to be capable of absorbing ten volumes of this gas when dried at 212° Fahr., and nearly as much when exposed to a red heat; but as this substance in solution has decided basic properties, it is probable the absorption in this instance is due to the exercise of these.

II. *Partial Solubility a Property possessed by Coal.*

a. Partial Solubility of Brown Coal.
b. Partial Solubility of Bituminous Coal.

Summary of Results.

From the experiments conducted under this department, it was found that a lignite of good average quality, compact and lustrous, is soluble in *pure* water to a considerable extent,—about 1-20th per cent. being thus soluble,—and that even in the case of a hard, compact bituminous coal of excellent quality, belonging to the carboniferous formation, this also has a small but very appreciable solubility in the same liquid. Allowing this last to be an exceptional case however, it might be argued (if, indeed, lignites are in a transitional state between dead vegetable matter and mineral coal) that the solubility of the lignite will be continued far into the coal proper; but the degree of it will gradually diminish until scarcely any method of testing would discover it, or until it be finally and completely lost in those members of the coal series farthest removed from the commencement.

III. *On the Influence which the Absorptive Power and Solubility of Carbonaceous Deposits exercises upon the Growth of Coal Seams.*

(1). Recapitulation of those facts already stated affecting the question at issue.

(2). Application of these phenomena.

In applying these various phenomena to explain how certain of the properties of the coal have been attained, the subject will be treated in the following manner. The first of the division is—

a. Absorption applied to increase the Compactness of Coal-Seams.

b. Absorption applied to increase their thickness. Two objections answered.

c. Absorption applied to convert Carbonaceous Clays into Bituminous Shale or impure Coal.

d. The lustre, hardness, and coherence of Coal possibly due to the exercise of its absorptive power and its partial solubility in water.

e. The absorptive power and solubility of Coal applied to increase the structural and chemical differences of adjoining parts.

Summary of Facts.

In summing up the several parts we find the absorptive power of the coal enables it to arrest those organic matters contained in common water, and a continual supply of such being kept up by the flow of the water down to the level of the sea, carrying the necessary material, we may have the compactness of the same largely augmented; all losses entailed by decomposition made good by interior absorption, or by a surface absorption, and thus these matters may be applied to build up the seam to a greater thickness. In the one case we require no miraculous interposition of pressure to remove the vesicularity which decomposition entails in the indurated mass; and in the other, in surface absorption, we reduce the difficulty we have in accounting for the remarkable thickness which has been attained by certain coal-seams.

These additions would be singularly free from earthy impurities of any kind, and therefore, no matter how great a thickness the

seam ultimately attained by this means may be, we should find it comparatively pure and uniform in composition. The whole roof of superincumbent material, however great its thickness might be, would be lifted up in detail, scarcely a particle would be left behind to attest the act.

In part (*c*) we find how this absorptive power may be applied with some degree of probability to account for the production of certain bituminous shales and impure coals, characterised by their homogeneity, and their poverty in vegetable structures. The whole process is nearly a repetition of what is supposed to occur in the case of coal itself, the only difference being, that in one case the absorbing substance is thinly dispersed through a quantity of earthy matters, while in the other it is in a concrete form.

In part (*d*) I have attempted to show in what manner the partial solubility of coal, together with its absorptive power, may have affected its physical character.

It has been supposed that the whole seam has been repeatedly turned over by these means, and each time reduced by the separation of portions of it, principally in the form of oxygenated compounds: the losses so incurred, however, being abundantly made up by introduced substances. It is, in fact, a continual re-solution and re-deposit.

Now, all these processes going on at an exceedingly slow rate, we are quite certain, judging from analogous cases, that ultimately the product so attained will cohere in all its parts, and be possessed of the utmost hardness and the highest degree of lustre of which its constitution admits.

In the last part (*e*), I have used these properties of coal to increase the differences in adjoining parts of the seam. To assist in this, and to give a greater completeness to the work, I have gone further back in the history of coal, and traced a supposititious origin for the *commencement* of these differences, using the suggestion of Bischoff, relating to the precipitation of the organic substances from water in the first instance. Thus I had horizontal cleavage and planes of greatest change readily afforded me; and to increase the differences so started and so directed, I had only to suppose that the rates of absorption for that part most decomposed, and that part least so, are unequal.

Thus every characteristic quality which distinguishes mineral coal from ordinary decomposed vegetable substances has now been considered, and, I think, provided for in the exercise of these its newly discovered properties of absorption and solubility.

Whether a slight elevation of temperature is necessary or no to assist in educing those members of the coal series, very far removed from the primary material, it is certain it would greatly facilitate the mineralisation of these deposits, but in either case it is the presence of water which, besides initiating the commencement of the required changes, allows of them being carried to the farthest point, by bringing the particles of the solid substances within reach of each other's affinities, thus determining the production of new combinations more insoluble, more carbonaceous, and more easily absorbed; and these being deposited as they were formed *slowly*, the hardness, coherence, and compactness of the deposit are ensured.

IV. *Popular theory, explaining the Physical Properties of Coal considered.*

As I have purposely avoided all along any reference to other theories respecting the formation of coal, in order that no external influence should be brought to secure favour for the views here propounded from prematurely showing up their deficiencies, preferring rather that they should stand thus long on their own merits uncontrasted with those of others. I hope now to be allowed to state a few objections—objections so obvious and so serious that they will have frequently occurred to the mind of the inquirer.

The principal agencies hitherto supposed to be involved in the formation of coal are decomposition, pressure, and heat. In regard to decomposition, important and indeed essential as it is to the formation of coal, it is still possible to overstate its influence. Taken by itself, it is obvious it cannot increase the hardness of coal. It is the property of decay rather to reduce than to increase the hardness of minerals, the most compact of which are thus modified, and especially should this be apparent in coal where it involves a positive loss of substance. This is well exemplified in the case of wood which has suffered the "dry rot, here, from the absence of water in sufficient quantity, there has been no recomposition" of the decomposed matters; hence even the colour is

unchanged, though the wood is exceedingly reduced in compactness. Nor even with the aid of pressure can we do more than increase the density; we bring their particles nearer together, but we do not affect the character of the particles themselves; if pressure could perform this, why should it not have been equally effective for the induration of clays or other soft hydrous minerals, which in certain states bear considerable resemblance to lignite, many of these having been subjected to pressure as great, or even far greater?

It is to a reconstruction of the residue from decomposition into new, more insoluble, and more permanent combination, that any great physical differences should be due, and to this only; this cannot, however, be effected while the particles of the solid vegetable matters are unable to move to each other's affinities while their position is fixed by cohesion; they must be brought into renewed chemical contact before they can enter into those combinations which give to coal qualities we have to account for.

If now we seek the assistance of an elevation of temperature sufficient to fuse or volatilize portions of the coal, so as to gain in this renewed chemical contact, so necessary for recomposition, we shall find that, although we may effect this, the results are not altogether of the kind we want.

Suppose we attempt to go no further than partial fusion, although we should certainly indurate its particles considerably, and give them some degree of lustre, and also effect favourable recomposition in the substance in regard to its chemical composition, we should certainly obliterate that laminated appearance coal often presents, and render the whole perfectly homogeneous, both in its physical character and chemical composition; and we should further most likely destroy the distinctions of those boundaries which separate the coal-seam from above or below, and also change their uniformity of direction. But, in all probability, in attempting the fusion only, we could not avoid decomposing a portion of the coal into gas, and this being mechanically retained by the semifluid mass, would render it porous throughout; and thus, although we might gain considerably in some of the properties of coal, such as those of hardness, lustre, coherence, we should lose in compactness—the vesicular appearance such a product would present would neutralise all we

have gained, and give it an appearance quite foreign to that of coal. But to what extent this porosity would be modified by the application of an immense pressure during the heating process we do not know; this, however, is almost certain, that if it did succeed in preserving or giving to the coal a more mineral appearance, it could but partially reduce its vesicularity, and never so much but that it would readily be discerned—the increase of hardness supposed to follow by this process would only help to impede the effect of pressure, and preserve to the vesicules their exact shape and size.

But in order to escape this, it may be argued that the gas in these pores has since been substituted by other matters in a state of fusion, or by condensed oils, &c. If, however, such had been really the case, we should surely have been able to observe indications of it in the amygdaloidal state of the coal so found, since we could scarcely have given us the same characters to substances whose chemical composition and manner of formation are so different; this appearance would be especially manifested at the junction of those bands in the coal before alluded to; in the place of the divisional places being as now perfect, there would be innumerable interruptions from some of the geodes occupying a position in both seams. That bands of a more recent date have obliterated the amygdaloidal appearance of the coal is too improbable to need any comment.

It would therefore appear, that though the hardness of coal may be increased, even into that of coke, by heat, the coal thus obtained would be rendered proportionately lighter and more porous; and that heat could induce the laminated appearance of coal, or favour its development, when begun, is very improbable, its effect would rather be to obliterate any previous lamination, and give to the coal a homogeneous appearance.

But besides these objections against the supposition that high temperature has been concerned in the production of coal from organic matters, there are others—the non-necessity of such for the production of these chemical differences we observe between them; for that there is no absolute necessity for this may be gathered from the heterogeneous nature of most samples of coals. In the case of the Newcastle coal, the difference in the parts, great as it is,

is not owing to any superior heat applied for the production of the more carbonaceous substance; for how, indeed, could superior heat be applied to these parts alone? Why, therefore, should not the bituminous coal be itself produced from brown coal without the aid of any increase of temperature over that which has obtained in its formation? there being no greater chemical difference between these than there is found to be between the bituminous coal and the fibrous anthracite.

But, besides the internal evidence afforded by coal itself that substances very rich in carbon can be eliminated at low temperatures, we have the authority of Bischoff for asserting, that for the elimination of a substance still further removed from organic matter (graphite) high temperatures are not necessary.

On the whole, it would therefore appear there is indeed no absolute necessity to provide any considerable elevation of temperature to bring about the chemical change required to convert decomposed organic matter into substances resembling anthracite; and further, it would also appear that hardness gained in such a manner would render the product porous, or, if these pores were subsequently filled, the anthracite would appear amygdaloidal.

Thus we have to rely upon the solvent powers of water as the only means by which recomposition can be effected,—as the only agency which can modify these vegetable substances in the manner we would wish, and which not only favours their decomposition, but allows of their recomposition and deposit as a hard, compact, coherent, and lustrous mineral.

In conclusion, I have to apologise for the incompleteness of these investigations; nothing but my inability to prosecute further researches for some time, owing to the removal of the laboratory to a distant part of the colony, and the consequent suspense of analytical operations, induces me to forward them in this state.

There was one part of the subject, especially, I was very anxious to examine further—that treating upon substitution—for it was apparent, if it could be ascertained whether or no gases are able to substitute each other, some further light would be shown upon the manner in which these absorptions are effected, since, in the absence of solvents, there would be fewer chemical affinities to interfere.

But it was more particularly in reference to the manner of the formation of coal as connected with its property of absorption that I was the most desirous to add to these investigations, and especially as to the precise action carbonic acid exercises during the absorption of decomposing organic matters. As to whether, in any case, these matters are able to substitute this acid when it has been previously absorbed to the coal.

If not anticipated, however, with permission, I intend communicating further upon these subjects, when the results of certain projected experiments relative to this are ascertained.

3. (1.) Description of *Erpetoichthys*, a new Genus of Ganoid Fish, from Old Calabar, Western Africa; forming an addition to the Family *Polypterini*. By John Alexander Smith, M.D., F.R.C.P.E. (Specimens of the fish were exhibited.)

In the beginning of January 1865, the author received from the Rev. Alexander Robb, Old Calabar, a package of specimens of natural history preserved in spirits. Among these were two small ganoid fish. They were, however, imperfect, having been torn across near the anal region, and their caudal extremities were wanting. The characters of the fish could not, therefore, be completely determined. The author, however, exhibited them at a meeting of the Royal Physical Society, on the 22d March 1865, and stated that they were allied to the genus *Polypterus;* but from various differences in character, to be afterwards detailed, and especially the great relative length of their bodies, and the apparently total absence of ventral fins, he would place them provisionally in a new genus, which, from their general aspect and form, he designated *Erpetoichthys*, the reptile or serpent fish; and the species, from the locality where it was found, he named *E. Calabaricus*.

Since that time the author had received perfect specimens from Old Calabar, and found that the accuracy of his previous conclusions were confirmed.

The fish is got in the fresh-water streamlets which run into the

main rivers or creeks of the great Calabar river, and in the pools of the marshy lands. It is occasionally sold in the markets, and eaten by some of the natives. Its native name is *U-nyãng*, which the Rev. Mr Robb explains, by suggesting that it may be derived from a verb signifying to struggle or scuffle for the possession of a thing, and he therefore supposes it to mean the struggler, or, using a Scottish word as more appropriate, the "wambler,"—the name being probably given to it, on account of the apparent struggling, wriggling, or undulating movements of its elongated body, as it swims in the water or mud of the river.

Summary of characters of the genus *Calamoichthys*,* and its relation to the genus *Polypterus* :—

Genus Calamoichthys.—*Head*, small, depressed above, somewhat oval in shape (rounded and narrow in front, expands laterally behind orbits, and contracts again at the back part, towards neck). Suboperculum wanting. (No small plates below preoperculum.) *Body*, much elongated; anguiform (cylindrical for about half its length, then becoming gradually more compressed laterally, and tapering slightly towards its caudal extremity). *Caudal extremity*, short, tapering rapidly. *Caudal Fin*, rounded; homocercal; fin-rays, hard. (*Scales*, osseous, rhombic, sculptured.) *Fins*, small—Pectorals, obtusely lobate, fin-rays soft; Dorsal finlets, numerous, separate; Anal (with fulcrum at base anteriorly), in male large, in female small; fin-rays hard; Ventrals, wanting.

The last character is rather an important one, as this fish thus appears to be the only living ganoid yet known which has no ventral fins. Van der Hoeven, in his "Handbook of Zoology," gives the presence of ventral fins as one of the characters of his great Section III. of the Class Pisces, the *Ganolepidoti;* and older naturalists, as Cuvier, place the ganoids, for a similar reason, among the *Malacopterygii Abdominales*. The discovery of this fish will therefore necessitate a change in this character of the whole section.

In the Genus Polypterus (on the other hand), the *Head* is rela-

* Since this paper was sent to press, the author has learned that a closely corresponding name to *Erpetoichthys* had been already used in Ichthyology; and, accordingly, he now changes the designation to *Calamoichthys* (Calamos and ichthys), which still bears a relation to the cylindrical shape of the fish.

tively larger (with apparently little or no lateral expansion and subsequent contraction towards neck); its gently swelling outlines gradually expand, and run backwards into those of the body. Suboperculum present; several small plates below preoperculum. *Body*, relatively much shorter, generally tapering gradually from behind region of pectoral fins, and becoming more compressed laterally, towards its caudal extremity. *Caudal extremity*, longer. *Scales*, generally smooth(?). *Fins*, larger—Pectorals, fin-rays, osseous; Anal, apparently alike in size in male and female; Ventrals, present.

The genus *Calamoichthys* agrees, however, with *Polypterus*, in the general character of its numerous dorsal finlets; lobate pectorals; two nasal cirri; a spiracle on each side of the head above; and a large flat branchiostegous ray or jugular plate, on each side of the mesian line below; and also in the hard, osseous, rhomboidal-shaped ganoid scales, arranged in rows, running obliquely backwards; and in the tapering caudal extremity of the body.

The new genus belongs, therefore, to the same family as *Polypterus*, and would accordingly fall to be placed next to it in the Family of the *Polypterini* :—

FAMILY POLYPTERINI.

I. Genus. POLYPTERUS.

II. Genus. CALAMOICHTHYS.

1. Species. *C. Calabaricus*.

(The specimens described measured from 8 to nearly 13 inches in length.)

Habitat, Old Calabar River, and the Camaroons, West Africa.

(A female sent by Mr G. W. Mylne from the latter locality, and recently received by Dr Smith, was also exhibited.)

For the purpose of getting an anatomical description of this new fish, Dr Smith placed several specimens of the males and females in the hands of Dr Ramsay H. Traquair, who was especially qualified for the task, from having made a careful dissection and study of a species of the genus *Polypterus*. Dr Traquair has accordingly prepared a detailed account of its anatomy.

(2.) Internal Structure of *Calamoichthys Calabaricus* (J. A. Smith.) By R. H. Traquair, M.D., Demonstrator of Anatomy in the University of Edinburgh.

On dissecting those specimens of *Calamoichthys*, entrusted to the author by Dr Smith, the greatest similarity was found to exist between their internal organisation and that of *Polypterus;* the chief differences being dependent on the great elongation of the body of the former fish, while the abdominal cavity extends proportionately still further back towards the caudal extremity than is the case even in the genus last mentioned.

The vertebræ resemble in construction exactly those of *Polypterus*, but are very much increased in number, amounting, in the specimen which was used for the preparation of the skeleton, to 110, the first of which has no body, consisting merely of neurapophyses, spinous process, and a pair of ribs. These latter form the first of the series of well-developed upper ribs, which extend in the horizontal intermuscular septum, as far back as the ninety-eighth vertebra. But the lower series of ribs are very deficient in development in comparison with those in *Polypterus*, where the whole series of abdominal vertebræ, except the first, is furnished with those appendages, which posteriorly attain a considerable length. In *Calamoichthys*, on the other hand, those lower ribs are very minute, and no trace of them was found in advance of the sixtieth vertebra. The number of abdominal vertebræ is, in the specimen alluded to, 100, of caudal, 10; showing the very great proportional elongation of the abdominal and shortening of the caudal region. The vertebral column projects beyond the last caudal vertebra, as a notochordal continuation or "Urostyle," concealed among the rays of the caudal fin. The bones supporting the fins agree in their general conformation with those in *Polypterus*,—there being, however, a less ossified state of the radius, ulna, and carpus, while the pelvic bones, along with the ventral fins, are completely absent. The first dorsal finlet is placed opposite the forty-ninth vertebra.

As regards the form and arrangement of the bones of the cranium and face, the most complete correspondence is found with those of *Polypterus*, a space being found, however, below the preoperculum, which, in various species of *Polypterus*, is defended by a variable

number of bony plates. The suboperculum is also completely absent. The arrangement of the mucus canals on the head is similar to that in *Polypterus*.

The arrangement of the muscular system corresponds in the two genera. In *Calamoichthys*, owing to the great increase of the number of vertebræ, the number of transverse segments of the great body muscle is also much larger. The muscular layer along the belly is very thin.

Viscera.—The œsophagus dilates into a flask-shaped stomach, which terminates behind in a *cul de sac*. From the interior part of the stomach, and close behind the entrance of the œsophagus, issues the intestine, which, passing first slightly forwards, makes almost immediately a turn on itself, and then proceeds straight back to the anus. A small cœcal appendage, with the apex directed forwards, is seen in connection with the intestine shortly after its backward flexure; and a little farther down, between this and the anus, a spiral valve of about five turns is developed in the interior. The liver was in none of the specimens examined very voluminous, but much elongated, being continued as a narrow stripe the whole length of the abdominal cavity. The gall-bladder is distinct, and opens into the intestine immediately after its flexure, and in front of the cœcum.

The heart is conformed, as in *Polypterus*, with muscular bulbus arteriosus, which is furnished internally with numerous valves of unequal size. The branchial artery gives off first a large lateral branch on each side, which divides into three for the three posterior gills; the trunk then bifurcates, giving off a branch for the anterior gill of each side. As in *Polypterus*, the posterior gill has only one row of leaflets, and the cleft behind it is wanting. No trace of a "Pseudobranchia" was found, an organ likewise absent in *Polypterus*. The spleen is very long and slender, lying closely along the great air-bladder. The air-bladders are two in number, opening by a common orifice into the lower aspect of the throat, behind the gill-clefts. That of the left side is small, being only $2\frac{5}{8}$ths inches in length on a fish of 10 inches; it is closely adherent to the side of the œsophagus and commencement of the stomach. That of the other side measures $8\frac{3}{4}$ inches on the same fish, and extends along the whole length of the abdominal

cavity, lying closely along the under surface of the vertebral column.

Like the rest of the abdominal organs in general, the kidneys are very slender and elongated; each consists of a number of little lobules, which lie in the concavities on the under surfaces of the vertebral bodies. The excretory duct or ureter lies along the outer border of the organ, and passes straight backwards to unite with the genital duct, and, with its fellow of the opposite side, at the urogenital pore. The ovaries and oviducts correspond exactly with Müller's description of these organs in *Polypterus* (*Trans. Berlin Acad.* 1844). Each ovary is in the form of a flattened plate, suspended in front of the posterior part of the kidney by a mesentery, is solid, and consists of a stroma imbedding ova of all sizes, up to $\frac{1}{14}$th of an inch in diameter. The oviduct, proceeding forwards from the urogenital pore as a pretty wide tube, crosses beneath the ovarian mesentery, and opens into the peritoneal cavity, on the outer side of the gland, and closely above its lower extremity. The ovaries are not symmetrical in position, one being in advance of the other, so that also one oviduct is longer. In a female measuring $8\frac{5}{8}$ths inches, the right ovary was $1\frac{1}{2}$ inch in length, its anterior extremity being placed $4\frac{5}{8}$ths inches from the top of the snout, and the length of the oviduct $1\frac{7}{8}$ths inch, while the left measured $1\frac{5}{8}$ths inch, was situated at its anterior extremity $5\frac{3}{8}$ths inches from the tip of the snout, and having a duct of $1\frac{3}{16}$ths inch. The testes are very minute, and situated very far forwards, each being a small oval body $\frac{3}{16}$ths inch in length, in a male of 10 inches; and in the same specimen the right one was situated $2\frac{1}{2}$, and the left $2\frac{1}{16}$ths inches back from the tip of the snout. A very minute duct runs backwards parallel with and close to the ureter, which it joins near the urogenital pore.

On opening a number of specimens, it was found that all those with a large anal fin were males, while those in which that organ was small were females. The females are, however, to be distinguished from the males by another character, namely, the much larger size of the urogenital pore, which is situated immediately behind the anus.

4. Professor Archer exhibited Jones Levick's Coal-Cutting Machine, and Mr David Price's Experiments on the Restoration of Oil Paintings.

A Model of the Great Pyramid, with specimens of the stones used in the external casing of it, was presented by Professor Piazzi Smyth, and thanks were voted.

The following Gentlemen were duly elected Fellows of the Society:—

John K. Watson, Esq.
W. D. Clark, Esq.
David Chalmers, Esq.

The following Donations to the Library were announced:—

Journal of the Statistical Society of London. Vol. XXIX. Part 1, 1866. 8vo.—*From the Society.*

Proceedings of the Royal Society of London. Vol. XV. No. 82. 8vo.—*From the Society.*

American Journal of Science and Arts. Vol. XLI. No. 122. New Haven, 1866. 8vo.—*From the Editors.*

Canadian Journal of Industry, Science, and Art. New Series. No. LXI. Toronto, 1866. 8vo.—*From the Canadian Institute.*

Journal of the Chemical Society of London. Vol. IV. No. 40. 8vo.—*From the Society.*

Monthly Notices of the Royal Astronomical Society, London, for 1865–66. 8vo.—*From the Society.*

Transactions and Journal of the Proceedings of the Dumfriesshire and Galloway Natural History and Antiquarian Society, Session 1863–64. Dumfries, 1866. 8vo.—*From Sir William Jardine, Bart.*

The Geological and Natural History Repertory and Journal of Pre-Historic Archæology and Ethnology. Nos. 10–12. London, 1866. 8vo.—*From the Society.*

Bulletin de L'Académie Royale des Sciences des Lettres et des Beaux-Arts de Belgique. Nos. 2, 3. Bruxelles, 1866. 8vo. —*From the Academy.*

Sur l'État de l'Atmosphére, a Bruxelles pendant l'Année 1865. Par M. Ernest Quetelet. 8vo.—*From the Author.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, 1865–66. Paris. 4to.—*From the Academy.*

Journal of the Society of Arts and of the Institutions in Union, for 1865–66. London. 8vo.—*From the Society.*

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